M.Tech (Civil Engineering)

Scheme of Instructions and Examination

and

Syllabus

(With effect from the academic year 2015-2016)

Department of Civil Engineering

A.U. College of Engineering(A)

Visakhapatnam

Department Of Civil Engineering
M TECH. (STRUCTURAL ENGINEERING)
Scheme of Instruction and Examination
(with effect from 2015-16 academic year)

I – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
ST 1.1	Theory of Elasticity	4	--	4	3	70	30	100	4
ST 1.2	Advanced Reinforced Concrete Design	4	--	4	3	70	30	100	4
ST 1.3	Matrix methods of Structural Analysis	4	--	4	3	70	30	100	4
ST 1.4	Industrial Structures	4	--	4	3	70	30	100	4
ST 1.5	a) Advanced Foundation Engineering b) Wind Analysis and Design of Tall Structures c) Experimental Stress analysis	4	--	4	3	70	30	100	4
ST 1.6	a) Advanced Concrete Technology b) Bridge Engineering c) Structural Dynamics	4	--	4	3	70	30	100	4
ST 1.7	Computer applications in Structural Engineering	--	3	3	Viva	50	50	100	2
ST 1.8	Design of Structures		3	3	Viva	50	50	100	2
Total		**24**	**6**	**30**		**520**	**280**	**800**	**28**

II – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
ST 2.1	Theory of Plates and Shells	4	--	4	3	70	30	100	4
ST 2.2	Structural Stability	4	--	4	3	70	30	100	4
ST 2.3	Finite Element Methods of Analysis	4	--	4	3	70	30	100	4
ST 2.4	Earthquake Engineering	4	--	4	3	70	30	100	4
ST 2.5	a) Ground Improvement Techniques b) Optimization Techniques c) Reliability Analysis and Design	4	--	4	3	70	30	100	4
ST 2.6	a) Prestressed Concrete b) Design of steel bridges c) Inelastic Design of Slabs	4	--	4	3	70	30	100	4
ST 2.7	Repair and Rehabilitation of Structures	--	3	3	Viva	50	50	100	2
ST 2.8	Advanced Design of Structures		3	3	Viva	50	50	100	2
Total		**24**	**6**	**30**		**520**	**280**	**800**	**28**

III and IV SEMESTERS

Code No	Course title	Scheme of Examination	Total Marks	Credits
ST3.1	Dissertation (Preliminary)	Viva-voce	**100**	**10**
ST4.1	Dissertation (Final)	Defence and Viva-voce	**100**	**14**

Department Of Civil Engineering

M TECH. (STRUCTURAL ENGINEERING)

Syllabus

(with effect from 2015-16 academic year)

I – SEMESTER

ST 1.1 : THEORY OF ELASTICITY

Plane Stress and Plane Strain: Components of stress, Strain, Hookes law, Stress and strain at a point. Plane stress, Plane strain, Equations of equilibrium, Boundary conditions, Compatibility equations stress foundation.

Two Dimensional Problems in Rectangular Coordinates: Solution by polynomials, Saint Vanant's principle determination of displacements, Bending of cantilever loaded at the end, Bending of a beam by uniform load.

Two Dimensional Problem in Polar Coordinates: General equations of equilibrium, Stress function and equation of compatibility with zero body forces. Analysis of thick cylindrical shells with symmetrical leading about the axis, Pure bending of curves bars, Strain components in polar coordinates, Rotating disks.

Three Dimensional State of Stress: Differential equations of equilibrium – Boundary conditions for compatibility – Displacements – Equations of equilibrium in terms of displacements – Principle of superposition – Uniqueness of solution.

Torsion: Torsion of straight bars – St.-Venant solution – Stress function, Warp function – Elliptic cross section – Membrane analogy torsion of bar of narrow rectangular cross section.

Analysis of Stress and Strain in Three Dimensions: Introduction – Principal stresses, - Determination of principal stress – Stress invariants – Maximum sheering stress strain at point.

Text Book:
1.“Theory of Elasticity” by Timoshenko and Goodier, McGraw Hill Company.

References:
1.“Theory of Elasticity” by Sadhu Singh, Khanna publishers
2 “Applied Elasticity” by C.T. Wang.
3.“Advanced Strength of Materials” by Denhortog.

ST 1.2 – ADVANCED REINFORCED CONCRETE DESIGN

Deflection of Reinforced Concrete Beams and Slabs: Introduction, Short-term deflection of beams and slabs, Deflection due to imposed loads, Short-term deflection of beams due to applied loads, Calculation of deflection by IS 456, Deflection of continuous beams by IS 456, Deflection of slabs.

Estimation of Crack width in Reinforced Concrete Members: Introduction, Factors affecting crack width in beams, Mechanisms of flexural cracking, Calculation of crack width, Simple empirical method, Estimation of crack width in beams by IS 456, Shrinkage and thermal cracking.

Redistribution of Moments in Reinforced Concrete Beams: Introduction, Redistribution of moments in fixed beam, Positions of points of contraflexures, Conditions for moment redistribution, Final shape of redistributed bending moment diagram, Moment redistribution for a two-span continuous beam, Advantages and disadvantages of moment redistribution, Modification of clear distance between bars in beams (for limiting crack width) with redistribution, Moment-curvature (M - ψ), Relation of reinforced concrete sections.
Approximation Analysis of Grid Floors: Introduction, Analysis of flat grid floors, Analysis of rectangular grid floors by Timoshenko's plate theory. Analysis of grid by stiffness matrix method, Analysis of grid floors by equating joint deflections, Comparison of methods of analysis, Detailing of steel in flat grids.

Design of Flat Slabs: Introduction, Proportioning of Flat Slabs, Determination of Bending moment and Shear Force, Direct Design method, Equivalent Frame method, Slab Reinforcement.

Bunkers and Silos : Introduction, Design of Rectangular Bunkers, Design of Tension member, Design of Circular Bunker, Design of Silos.

Chimneys : Introduction, Design factors, Stresses due to Self Weight and Wind load, Stress in horizontal reinforcement, Temperature Stresses, Combined effect of Self Weight, Wind load and Temperature, Temperature stresses in Hoop(Horizontal) Reinforcement.

Design of Reinforced Concrete Members for Fire Resistance: Introduction, ISO 834 standard heating conditions, Grading or classifications, Effect of high temperature on steel and concrete, Effect of high temperatures on different types of structural members, Fire resistance by structural detailing from tabulated data, Analytical determination of the ultimate bending moment, Capacity of reinforced concrete beams under fire, Other considerations.

References:
      1."Advanced Reinforced Concrete Design" by P.C. Varghese.
      2."Reinforced Concrete" by Park & Paulay.

ST 1.3 MATRIX METHODS OF STRUCTURAL ANALYSIS

Introduction to Matrix methods: Introduction, coordinate systems, displacement and force transformation matrices, element and structure stiffness matrices, Element and structure flexibility matrices, equivalent joint loads, stiffness and flexibility approaches.

Matrix methods for beams: Analysis of beams, fixed and continuous beams by flexibility method. Analysis of beams, fixed and continuous beams by stiffness method.

Matrix methods for Plane truss problems: Analysis of 2-D trusses by flexibility method. Analysis of 2-D trusses by stiffness method

Matrix methods for Plane Frames: Analysis of 2-D frames by Flexibility matrix methods. Analysis of 2-D frames by Stiffness matrix methods.

References:

1. Devdas Menon,"Advanced StructuralAnalysis", Narosa Publishing House, 2009.
2. Asslam Kassimali,"Matrix Analysis of Structures", Brooks/Cole Publishing Co., USA, 1999.
3. Analysis of Inderminate structures – C.K Wang 2. Matrix Analysis of framed Structures-W Weaver& Gere.
4. G.S.Pandit, S.P.Gupta, "Matrix methods of Structural Analysis", Tata McGraw Hill Co..
5. William Weaver, James M. Gere, "Matrix Analysis and Framed Structures", D. Van Nostrand Co., 1980.

ST 1.4 - INDUSTRIAL STRUCTURES

Plastic Analysis: Introduction, Limit analysis of steel structures, Mechanical properties of structural steel, Plastic hinge, Moment curvature relations, Limit load, Coplanar load, Upper lower bound theorems. Redistribution of moments continuous beams: Relevant or irrelevant mechanisms, Types of mechanisms method for performing moment check. Portal frame, Mechanisms, Combination of mechanisms, Moment check, Partial complete and over complete collapse.

Light gauge steel structures: Local buckling of thin sections, Post packing of thin elements, Light gauge steel columns and compression members, Form factor for columns and compression members, Stiffened compression elements, Multiple stiffened compression elements, Unstiffened compression elements effective length of light gauge steel compression members, Basic design stress, Allowable design stress, Light gauge steel beams, Laterally supported light gauge steel beams web crippling. Allowable design stress in beams, Beams subjected to combined axial end bending stress, connections.

Analysis of Communication Towers: Analysis of Transmission line Towers: Loads on towers, Sag (dip) and Tension in uniformly loaded conductors, Analysis of towers (analysis as coplanar

assembly), Design of members in towers, Design of foundation of towers.Design of Steel Chimneys for wind and gravity loads.

Design of gantry girder

References:

1. "Plastic Analysis of Structures" by Beedle.
2. "Design of Steel Structures" by Arya & Ajmani, Nemchand Publishers.
3. "Comprehensive Design of Steel Structures", B.C.Punmia,Ashok Kumar Jain, Arun Kumar Jain, Laxmi Publications (P) Ltd

ST 1.5 a) ADVANCED FOUNDATION ENGINEERING

Introduction: Principles of Design of Foundations, Types of shear failures in foundation soils, Types of foundations, Design Loads, Basic Concepts of safe and allowable bearing capacity.Shallow Foundations

Bearing Capacity Analysis: Bearing capacity theories – Terzaghi, Meyerhof, Skempton, Hansen, Vesic and IS Methods, Bearing capacity evaluation from Standard Penetration test and Plate load test.

Settlement Analysis: Uniform and Differential Settlements, Elastic and Consolidation Settlements, Settlement analysis in cohesion less soils by Schemartmann and Hartman method, Penetration tests; Permissible settlements as per IS 1904-1978, causes of settlement, settlement Control.

Proportioning of footings: Isolated column footings, Strip, combined Footings and Strap Footing.

Raft Foundations: Bearing capacity of raft foundation, floating raft, Types of rafts, Beam on Elastic foundation and Conventional methods of Design, determination of modulus of subgrade reaction.

Deep Foundations : Pile Foundations: Types, load capacity- dynamic formulae, static formula; pile load tests- Vertical load test, lateral load test, Cyclic load test; settlement of piles and pile groups, negative skin friction on single pile and pile groups; laterally loaded piles - Broom's Analysis, IS Code method; Under reamed piles – Load capacity, design and construction.

Well Foundations: Types, Bearing Capacity of well foundations, Construction of pneumatic caissons, Tilts and Shifts: precautions, Remedial measures; Lateral stability analysis by Terzaghi's Method, Design aspects of Components of well foundation.

Foundations in Expansive Solis : Introduction, Identification of expansive soils, Swell potential and swelling pressure, Active depth, Foundation Problems, Foundation practices in expansive soils, Soil Replacement and 'CNS' concepts.

Foundations of Transmission Line Towers : Introduction, Necessary information, Forces on tower foundations, General design criteria, Choice and type of foundation, Design procedure.

Reference Books:
1. Foundation Analysis and Design by J.E. Bowles, Mc Graw Hill Publishing Co.
2. Foundation Design by W.C. Teng, John Wiley, New York.
3. Analysis and Design of Substructures by Swami Saran, Oxford &IBH Publishing Co.
4. Foundation Engineering by P.C. Vargheese, Prentice Hall of India
5. Basic and Applied Soil Mechanics by Gopal Ranjan and A.S.R. Rao, New Age International Publications

ST 1.5b) WIND ANALYSIS AND DESIGN OF TALL STRUCTURES

Introduction: Basic wind speed, Design wind speed, Design wind pressure, offshore wind velocity, wind pressures and forces in buildings/structures, External pressure coefficients for various roofs, dynamic effects.

Lateral load Analysis of Multistory Building Frames : Analysis of Multistory Building Frames for lateral loads, Cantilever method, Portal method and Factor method.

Design of Shear Wall: Introduction, Types of shear walls, Behaviour of cantilever wall with rectangular cross-section, flange cantilever shear walls, Moment-Axial load interaction for shear wall section, Interaction of shear walls and rigid joined frames, Shear walls with openings, Coupled shear walls.

Design of Chimneys (RCC): Introduction, Wind pressure, Stress in chimney shaft due to self weight and wind, Stress in horizontal reinforcement due to wind shear, Stresses due to temperature difference. Design of RC chimney.

Bunkers and Silos: Introduction, Differences between bunker and silo, Design of square or rectangular bunkers, Design of circular bunkers, Design of silos, Silos for storage of cement.

Multistory Building Frames: Analysis of multistory frames, Method of substitute frames,Bending moments in beams and columns.

References:
1. "Reinforced Concrete Structures" by Park, R. & Paulay, T.
2. "Advanced Reinforced Concrete Design",by N.Krishna Raju
3. "Reinforced Concrete Structures" by Punmia, Jain & Jain.
4. "Tall Chimneys" by Manohar, S.N.
5. "Design of Steel Structures"by N.Subramanian

ST 1.5 c) EXPERIMENTAL STRESS ANALYSIS

Analysis of Stress, strain, Stress- Strain relation and theories of failure

Electrical Resistance Strain Gauges: Principle of operation and requirements, Types and their uses, Materials for strain gauge. Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators.

Photoelasticity: Two dimensional photo elasticity, Concept of light – photoelastic effects, stress optic law, Interpretation of fringe pattern, Compensation and separation techniques, Photo elastic materials. Introduction to three dimensional photo elasticity.

Brittle Coating And Moire Methods : Introduction to Moire techniques, brittle coating methods and holography.

Text Books

1. "Experimental Stress Analysis", Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., , Tata McGraw-Hill, New Delhi, 1984.
2. Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", McGraw-Hill Inc

ST 1.6 a: ADVANCED CONCRETE TECHNOLOGY

Durability of concrete and concrete construction: Durability concept, pore structure and transport processes, reinforcement corrosion, fire resistance, frost damage, sulphate attack, alkali silica reaction, delayed ettringite formation, methods of providing durable concrete, short-term tests to assess long-term behaviour.

Mix design: Review of methods and philosophies of IS, BS and ACI methods, mix design for special purposes. Acceptance criteria for compressive strength of concrete

Special concretes: Lightweight concrete, autoclaved aerated concrete, no-fines concrete, lightweight aggregate concrete and foamed concrete, High strength concrete, refractory concrete, high density and radiation-shielding concrete, polymer concrete, fibre-reinforced concrete, mortars, renders, recycled concrete, Ferro Cement, Self Compacting Concrete.

Special processes and technology for particular types of structure: Sprayed concrete, underwater concrete, grouts, grouting and grouted concrete, mass concrete, slip form construction, pumped concrete, concrete for liquid retaining structures, vacuum process, concrete coatings and surface treatments.

Test methods: Analysis of fresh concrete, Accelerated testing methods, Tests on hardened concrete, Core cutting and testing, partially destructive testing, Non-destructive testing of concrete structures

References:

1. Properties of Concrete, A.M.Neville, Longman 1995.
2. Concrete micro-structure, Properties and Materials, P.K.Mehta, J.M.Monteiro, Printice Hall INC & McGraw hill, USA.
3. Concrete Technology Theory and Practice, M.S.Shetty, S.Chand & Company Ltd, New Delhi.

ST 1.6 b BRIDGE ENGINEERING

Introduction to bridge engineering. Historical background of bridges and types. Bridge aesthetics and proportioning. Design process. Review of applicable design codes. Loads on bridges and force distribution. Bridge geometry.

Analysis and design of Slab Bridge, Skew slab bridge.

Analysis and design of T-beam bridge: Deck slab considering IRC loads, longitudinal girders(Interior, Exterior), Cross girder.

Analysis and design of prestressed concrete girder and box girder bridges considering only primary torsion, Design of end block.

Bridge Bearing: Types of bearings, Rocker bearing, Elastomeric bearing.

Text books:
1. "Essentials of Bridge Engineering", D. Jhonson Victor, Oxford University Press.
2. "Design of Bridges", N.Krishna Raju, Oxford & IBH Publishing Co.Pvt.Ltd, New Delhi

ST 1.6 C – STRUCTURAL DYNAMICS

One Degree Systems: Undamped systems, Various forcing functions damped systems, Response to pulsating force, Support motion.

Lumped Mass Multidegree System: Direct determination of natural frequencies, Characteristic shapes, Stodola-Vianelle method, Modified Rayleigh-Ritz method, Lagrange's equation, Model analysis of multi degree systems, Multistorey rigid frames subjected to lateral loads, Damping in multi degree systems.

Structures with distributed mass and load, Single span beams, Normal modes of vibration, Forced vibrations of beams, Beams with variable cross-section and mass.

Approximate design methods, Idealized system, Transformation factors, Dynamic reactions response calculations, Design example (RC beam, Steel beam and RC slab), Approximate design of multi degree systems.

Matrix Approach: Coordinates and lumped masses, Consistent mass matrix, Undamped force vibration of a system with one degree freedom, Response of single degree freedom undamped system, Viscous damped vibration of a single degree freedom system, Undamped vibration of multi degree freedom system, Orthogonality of natural nodes, Normal coordinates.

Books:
1. "Structural Dynamics" by John M. Biggs.
2. "Structural Analysis" by A. Ghali & A.M. Neville.

ST 1.7– COMPUTER APPLICATIONS IN STRUCTURAL ENGINEERING

Application of software's in Structural Engineering (by using STAAD Pro,ETABS, STRAP, STRUDS etc) for the following problems.
1. Analysis and Design of Beams.
2. Analysis and Design of Footings.
3. Analysis and Design of Trusses.
4. Analysis and Design of Two Dimensional Frames.
5. Analysis and Design of Three Dimensional Frames.
6. Analysis and Design of Water Tanks.
7. Analysis and Design of Steel Members.
8. Implementation of Concepts of FEM using a Computer Language.

ST 1.8 - DESIGN OF STRUCTURES (VIVA-VOCE)

On Any **THREE** of the following:

1. Design of Folded Plates
2. Elevated Service Reservoirs
3. Retaining walls
4. Grid floor
5. Flat slab
6. Pressed steel tank
7. Buried pipes

Department Of Civil Engineering

M TECH. (STRUCTURAL ENGINEERING)

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(with effect from 2015-16 academic year)

II – SEMESTER

ST 2.1 – THEORY OF PLATES AND SHELLS

Bending of Long Rectangular Plates to a Cylindrical Surface: Differential equation for cylindrical bending of plates – Uniformly leaded rectangular plates with simple supported edges and with built in edges. Pure bending of plates slopes – Curvatures of bent plates – Relations between bending moments and curvature – Particular cases – Strain energy in pure bending – Limitations.

Symmetrical Bending of Circular Plates: Differential equation – Boundary conditions. Simply supported rectangular plates under sinusoidal loading – Naviers solution and its application to concentrated load – Levy's solution for uniformly distributed load or hydrostatic pressure – Bending of rectangular plates by moments distributed along the edges – Differential equation of rectangular plate within plane and lateral forces.

Membrane analysis:
a) Shells of revolution (axi-symmetrical loading), Spherical shells, Conical shells, Elliptical shell of revolution, Torus, Hyperboloid of revolution of one sheet, Shells of uniform strength membrane deformation.

b) Membrane analysis of shells of translation, Circular cylinder, Diretrix, Parabola, Cycloid, Catenary and Membrane deformations.

c) Membrane analysis of shells of general shape: Anticlastic, Synclastic shells, Hyperbolic paraboloid, Candella shells, Conoid, Elliptic paraboloid, Rotational paraboloid.

Bending analysis of cylindrical shell: Beam method, Schorer method, Finsterwalder method. Classification analysis.

Text Books:
1. "Theory of Plates and Shells" by Timoshenko, S. and Wernewsky-Kriegar.
References:
1. "Design of Reinforced Concrete Shells and Folded Plates" by P.C.Varghese
2. "Stresses in Shells" by Flugge.
3. "Design and Construction of Shells" by Ramaswamy, G.S.

ST 2.2 – STRUCTURAL STABILITY

Buckling of Columns: Method of neutral equilibrium, Critical load of the Euler column, Linear column theory – An eigen value problem, Effective length concept, Higher order differential equation for columns initially bent columns, Effect of shear stress on buckling, eccentrically loaded columns, beam columns (Beam columns with concreted lateral load, distributed, load end moment), Inelastic buckling of columns, Double modulus theory, Tangent modulus theory, Shanley theory of inelastic column behaviour.

Approximate Methods of Analysis: Conservation of energy principles, Calculation of critical loads using approximate deflection curve, Principle of stationary potential energy, Raleigh-Ritz method, Buckling load of column with variable cross-section, Galerkin's method, Calculation of critical load by finite differences, Unevenly spaced pivot points, Matrix stiffness method, Effect of axial load on bending stiffness-slope deflection equations, Buckling of column loaded along the length using energy methods.

Buckling of Frames: Modes of buckling, Critical load of a simple frame using neutral equilibrium, Slope deflection equations and matrix analysis. Lateral buckling of cantilever and simply supported beams of rectangular and I-sections and use of energy method and finite differences.

Buckling of Plates: Differential equation, Strain energy of bending, Critical load, Finite difference approach inelastic buckling of plates.

Matrix approach for Frames: Criterion for determination of critical loads, Stiffness influence coefficients for members without axial load, Derivation of stability functions, Problem involving Non-sways, Modified stiffness of beams, Frames with sway, Multi-bar frames.

References:
1."Principles of Structural Stability Theory" by Alexander Chajes.
2."Theory of Elasticity Stability" by Timoshenko and Gere.

ST 2.3 FINITE ELEMENT METHODS OF ANALYSIS

Introduction: A brief history of F.E.M. Need of the method, Review of basic principles of solid mechanics- Equations of equilibrium, Boundary conditions, Compatibility, Strain displacement relations, Constitutive relationship in matrix form, plane stress & plane strain and axisymmetric bodies of revolution with axi-symmetric loading, Energy principles - Raleigh - Ritz method of functional approximation.

Theory relating to the formulation of the finite element method, Coordinate system (local and global), generalized coordinates, Concept of the element, Various element shapes, Discretisation of a structure, Mesh refinement Vs. Higher order element, Interconnections at nodes of displacement models, inter element compatibility, -shape functions.

Basic component – One dimensional FEM single bar element, Beam element : Derivation of stiffness matrix, Assembly of stiffness, Matrix boundary conditions, shape functions for 1 D elements, Initial strain and temperature effects, and trusses under axial forces.

Two dimensional FEM**:** Different types of elements for plane stress and plane strain analysis – Displacement models Generation of element stiffness and nodal load matrices –static condensation.

Isoperimetric representation and its formulation for 2d analysis. Formulation of 4-noded and 8-noded isoparametric quadrilateral elements – Lagrangian elements-serendipity elements.

References :

1.   Introduction to Finite element Method by Tirupathi chandra Patla and Belugundu
2.   C.S.Krishnamoorthy, (2002), Finite Element Analysis, Tata McGraw Hill Publishing Co. Ltd.
3.   The Finite Element Method in Engineering Science" by Zienkiewicz, P., McGraw Hill, 1971.
4.   Introduction to Finite Element Method by Desai,C.S.and Abel, J.F.,Van Nostrand, 1972.

ST 2.4 EARTHQUAKE ENGINEERING

One Degree Systems: Undamped systems, Various forcing functions damped systems, Response to pulsating force, Support motion. Lumped Mass Multidegree System: Direct determination of natural frequencies, Characteristic shapes, Stodola-Vianelle method, Modified Rayleigh-Ritz method, Lagrange's equation, Model analysis of multi degree systems, Multistorey rigid frames subjected to lateral loads, Damping in multi degree systems.

Matrix Approach: Coordinates and lumped masses, Consistent mass matrix, Undamped force vibration of a system with one degree freedom, Response of single degree freedom undamped system, Viscous damped vibration of a single degree freedom system, Undamped vibration of multi degree freedom system, Orthogonality of natural nodes, Normal coordinates.

Earthquakes, Epicenter, Hypocenter and earthquake waves, Measurement of ground motion, Seismic regions, Intensity and Isoseismals of an earthquake, Magnitude and energy of an earthquake, Consequences of earthquakes, Seismic zoning. Earthquake Response of Linear Systems: Earthquake excitation, Equation of motion, Response quantities, Response history, Response spectrum concept, Deformation, Pseudo-velocity, and Pseudo-acceleration, Response spectra, Peak structural response from the response spectrum, Response spectrum characteristics, Elastic design spectrum, Comparison of design and response spectra, Distinction between design and response spectra.

Earthquake analysis of Multistorey buildings: By seismic coefficient method and Response spectrum method, Base shear, Fundamental period of buildings, Distribution of forces along the height

Earthquake analysis of Water towers: Introduction, Behaviour under earthquake loads, Design features, Water tower as a rigid jointed space frame, Hydrodynamic pressures in tanks.

Earthquake analysis of Stack like structures: Introduction, Fundamental period of vibration, Dynamic bending moment, Shear diagram

Earthquake analysis of dams: Hydrodynamic pressures on dams, Zanger's method, Vertical component of reservoir load, Concrete or masonry gravity dams

Books:
1.   "Structural Dynamics" by John M. Biggs.
2.   "Structural Analysis" by A. Ghali & A.M. Neville.
3.   "Elements of Earthquake Engineering" by Jaikrishna and Chandrasekharan, Saritha Prakasham, Meerut.
4.   "Dynamics of Structures, Theory and Applications to Earthquake Engineering" by Anil K. Chopra, Prentice Hall of India.
5.   "Earthquake resistant design of structures" by S.K.Duggal, Oxford University Press.
6.   "Earthquake resistant design of structures" by Pankaj Agarwal and Manish Shrikhande, Prentice Hall of India Pvt. Ltd.

ST 2.5 a GROUND IMPROVEMENT TECHNIQUES

Compaction: Theory of compaction, Shallow Surface Compaction - Equipment, Placement water content, factors affecting shallow compaction; Deep compaction: Methods - Vibrofloatation, Terra probe method, Pounding, Blasting, Compaction piles; Compaction Control.

Vertical Drains: Sand drains, Sand wicks, Rope drains, Design of vertical drains, Stone columns, application of the techniques to Marine clays.

Stabilization: Introduction, objectives, Methods of stabilization – Mechanical, Cement, Lime, Bituminous, Calcium chloride; construction methods, factors affecting stabilization of soils; Deep Mixing methods – Soil lime Columns and Cement Lime Columns, applications

Dewatering: Definition, necessity, Methods of dewatering – Interceptor ditch, Single, Multistage and Vacuum well points, Horizontal wells, Electro-osmosis. Permanent drainage by Foundation drains and Blanket drains.

Grouting: Definition, Objectives of grouting, Grouts and their properties, Categories of Grouting, Grouting methods: Asending, Descending and Stage Grouting in Soils, Hydrofracture, Grouting Equipment, Post grouting tests. In-situ Reinforcement: Ground Anchors, Tiebacks and Soil Nailing, Micropiles.

Reference Books
1.   Engineering Principles of Ground Modification by Monfred R Hausmann, Mc Graw Hill
Publishing Co.
2.   Ground Improvement Techniques by P. Purushothama Raj, Laksmi Publications, New
Delhi.

ST 2.5 b – OPTIMIZATION TECHNIQUES

Introduction: Need and scope of optimization, Historical development, Statement of an
optimization problems, Objective function and its surface, design variables, constraints and
constraint surface. Classification of optimization problems, various functions (continuous,
discontinuous, and discrete) and Function behaviour (Monotonic, Non-Monotonic and Uni-
modal)

Classical Optimization Techniques: Differential calculus method, Multivariable optimization by
method of constrained variation and Lagrange multipliers (generalized problem). Kuhn-Tucker
conditions for optimality.
Fully stressed design and optimally criterion based algorithms, Introduction, Characteristics of
fully stressed design theoretical basis – Examples.

Non-linear Programming: Unconstrained minimization – Fibonacci, Golden section, Quadratic
and Cubic interpolation methods for a one-dimensional minimization and Univariate Method,
Powel's method, Newton's method and Davidon Fletcher Powell's method for multivariable
optimization. Constrained minimization – Cutting plane method, Zoutendijk's method and
penalty function methods.

Linear programming – Definitions and theorems – Simplex method – Duality in linear
programming. Plastic analysis and minimum weight design and rigid frame.

Introduction to quadratic programming, Geometric programming and Dynamic programming.
Design of beams and frame using dynamic programming technique.

References:
1. "Optimization Theory and Applications" by Rao, S.S., Wiley Eastern Ltd., New Delhi,
    1978.
2. "Mathematical Foundations for Design: Civil Engg. Systems" by Robert, M. Stark and
    Robert L. Nicholls, McGraw Hill Book Company, New York, 1972.
3. "Optimum Structural Design, Theory and Applications", Edited by Gallegher, R.H. and
    Zienkiewiez, O.C., John Wiley and Sons, New York, 1973.
4. "Optimum Design of Structures" by Majid, K.I., Newnes-Butter Worths, London, 1974.

ST 2.5 c – RELIABILITY ANALYSIS AND DESIGN

Concepts of Structural Safety: General, Design methods.

Basic Statistics: Introduction, Data reduction, Histograms, Sample correlation.

Probability Theory: Introduction, Random events, Random variables, Functions of random variables, Moments and expectation, Common probability distribution, Extremal distribution.

Resistance Distributions and Parameters: Introduction, Statistics of properties of concrete, Statistics of properties of steel, Statistics of strength of bricks and mortar, Dimensional variations, Characterization of variables, Allowable stresses based on specified reliability.

Probabilistic Analysis of Loads: Gravity loads, Wind load.

Basic Structural Reliability: Introduction, Computation of structural reliability. Monte Carlo Study of Structural Safety: General, Monte Carlo method, Applications.

Level 2 Reliability Methods: Introduction, Basic variables and failure surface, First-order second-moment methods (FOSM).

Reliability Based Design: Introduction, Determination of partial safety factors, Safety checking formats, Development of reliability based design criteria, Optimal safety factors, Summary of results of study for Indian standard – RCC design. Reliability of Structural Systems: Preliminary concepts as applied to simple structures.

References:
1.   "Structural Reliability Analysis and Design" by Ranganatham, R.
2.   "Structural Reliability" by Melchers, R.E.

ST2.6a - PRESTRESSED CONCRETE

Introduction: Basic concepts of prestressing need for high strength steel and concrete, advantages of prestressed concrete. Materials for prestressed concrete, high strength concrete and high strength steel.

Prestressing systems and losses of prestress: (1) Freyssinet Anchorage System (2) Gifford Udall System (3) Magnel-Blaton System, Tensioning devices, anchoring devices. (d) Pretensioning and Post tensioning. Prestressing losses, Elastic shortening, loss due to shrinkage, loss due to creep, loss due to friction, loss due to slip etc. I.S.code provisions.

Analysis of prestressed Concrete Beams: Assumptions, Analysis of prestress, Resultant stresses at a section, pressure or thrust line, concept of load balancing, cable profile, kern distance, stress in tendons as per IS 1343, cracking moment.

Shear and Torsional Resistance of Prestressed Concrete Members: Shear and Principal Stresses, Ultimate Shear Resistance of Prestressed Concrete Members, Design of Shear Reinforcements, Prestressed Concrete members In Torsion, Design of Reinforcements for Torsion, Shear and Bending

Transfer of prestress in Pretensioned members: Transmission length, bond stress, Transverse tensile stress, End Zone reinforcement, flexural bond stress, I.S. Code Provisions.

Anchorage zone in post tensioned members: Introduction, stress distribution in End block, Investigation on Anchorage Zone Stresses- Magnel's method, Guyon's method of approach of analysis of end block (Not more than 2 cables).

Deflection of Prestressed Concrete Members: Importance of Control of Deflections, Factors Influencing Deflections, Short-Term Deflection of Uncracked members, Prediction of Long Time Deflections, Deflection of Cracked Members, Requirements of various Codes of Practice.

Text Book:
    1. Prestressed Concrete by N.Krishna Raju.
References:
1.   Prestressed Concrete by N.Rajagopalan.
2.   Prestressed Concrete by P. Dayaratnam.
3.   Design of Prestressed Concrete Structures by T.Y. Lin and Ned. H. Burns.

ST 2.6 b DESIGN OF STEEL BRIDGES

Steel Bridges: Introduction, classification of steel bridges, economical span, clearance requirements, dimensions of rolling stock, width of roadway and footway

Loads: Live load for Railway, Highway and combined rail cum road bridges, Impact effect, wind load, lateral force (racking force), longitudinal forces, centrifugal forces, seismic forces, temperature effects

Plate girder bridges: Introduction, types, general arrangement, wind load effects, analysis and design of Deck type plate girder bridge for railways, analysis and design of Half-through plate girder bridge for railways, analysis and design of Through type plate girder bridge for railways,

Truss girder bridges: Introduction, general arrangement of components of truss girder bridge, self-weight of Truss girder bridge, wind load and wind effects, analysis of portal bracing, analysis and design of through type truss girder bridge

Bearings : Introduction, IS code requirements for bearings, Types of bearings, plate bearing, Rocker bearing, Roller bearing, Knuckle pin bearing, Railway board roller bearing

References:
1.   Design of Steel structures by N. Subramanian, Oxford University Press.

2.   Limit State Design of steel structures – Ramchandra and Virendra Gehlot, Scientific Publishers (India)
3.   Comprehensive design of steel structures-B.C.Punmia, Ashok Kumar Jain and Arun Kumar Jain, Laxmi Publications (P) Ltd.

ST 2.6 c INELASTIC DESIGN OF SLABS

Basic elastic theory Analysis: Classical plate theory, Lagrange's equation, moment-deformation, shear-deformation relationships. Examples on square and rectangular plates carrying uniformly distributed load for different edge conditions.

Principles of yield line theory: slab reinforcement, section behavior and conditions at ultimate load. Yield lines as axes of rotation and basic rules for the determination of the pattern of yield lines. Different yield line patterns for rectangular and non rectangular slabs supported on three and four sides with different edge conditions.

Analysis by principle of virtual work: Derivation of virtual work equations for Isotropic and Orthotropic two-way Square/ Rectangular slabs supported on four sides for different edge conditions.
Analysis of rectangular/Square slabs supported on three sides with different edge conditions and one edge is free (Balcony slabs) using virtual work principle.

Analysis of rectangular/Square slabs supported on three (Balcony slabs) and four sides with different edge conditions using equilibrium method.

Design of rectangular/Square slabs supported on three (Balcony slabs) and four sides for different edge conditions.

Derivation of virtual work equations only, for two-way slabs supported on four sides with different edge conditions having openings at centre, central eccentric, corner, central short side and central long side.

Text Books
1.   "Reinforced Concrete Slabs", Robert Park, William L Gamble , JOHN WILEY &SONS. INC, New York., 2010.
2.   "Ultimate Strength Design for Structural Concrete". V.Ramakrishnan, P.D.Arthur. Wheeler books.
3.   R H Wood and LL Jones "Yield line Analysis of Slabs". Thames and Hudson, Chatto & Windus, London,1967

ST 2.7 –REPAIR AND REHABILITATION OF STRUCTURES

Materials: Construction chemicals, Mineral admixtures, Composites, Fibre reinforced concrete, High performance concrete, Polymer-impregnated concrete.

Techniques to Test the Existing Strengths: Destructive and non-destructive tests on concrete.

Repairs of Multi-storey Structures: Cracks in concrete, Possible damages to the structural element beams, Slab, Column, Footing, etc., Repairing techniques like Jack Chu, Grouting, External pre-stressing, Use of chemical admixtures, Repairs to the fire damaged structure.

Repairs to Masonry Structures & Temples: Damages to masonry structures – Repairing techniques, Damages to temples – Repairing techniques.

Foundation Problems: Settlement of soils – Repairs, Sinking of piles – Repairs.

Corrosion of Reinforcement: Preventive measures – Coatings – Use of SBR modified cementitious mortar, Epoxy resin mortar, Acrylic modified cementitious mortar, Flowing concrete.

Temporary Structures: Need for temporary structures under any Hazard, Various temporary structures, Case-studies.

Case Studies: At least 2 case studies per each student.

References:
1.   "Renovation of Structures" by Perkins.
2.   "Repairs of Fire Damaged Structures" by Jagadish, R.
3.   "Forensic Engineering" by Raikar, R.N.
4.   "Deterioration, Maintenance and Repair of Structures" by Johnson, McGraw Hill.

ST 2.8 ADVANCED DESIGN OF STRUCTURES (VIVA-VOCE)

On Any **THREE** of the following:

1. Design of blast resistant structures
2. Design of berth structures
3. Design of Quay Walls
4. Pre-engineered buildings
5. Bow string girder bridge
6. Balanced cantilever bridge
7. Raft design
8. Design of Piles and pile caps

Department Of Civil Engineering
M TECH. (STRUCTURAL ENGINEERING and NATURAL DISASTER MANAGEMENT)
Scheme of Instruction and Examination
(with effect from 2015-16 academic year)

I – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
STNDM 1.1	Theory of Elasticity	4	--	4	3	70	30	100	4
STNDM 1.2	Advanced Reinforced Concrete Design	4	--	4	3	70	30	100	4
STNDM 1.3	Matrix methods of Structural Analysis	4	--	4	3	70	30	100	4
STNDM 1.4	Industrial Structures	4	--	4	3	70	30	100	4
STNDM 1.5	d) Advanced Foundation Engineering e) Wind Analysis and Design of Tall Structures f) Experimental Stress analysis	4	--	4	3	70	30	100	4
STNDM 1.6	d) Advanced Concrete Technology e) Bridge Engineering f) Structural Dynamics	4	--	4	3	70	30	100	4
STNDM 1.7	Computer applications in Structural Engineering	--	3	3	Viva	50	50	100	2
STNDM 1.8	Design of Structures		3	3	Viva	50	50	100	2
Total		**24**	**6**	**30**		**520**	**280**	**800**	**28**

II – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
STNDM 2.1	Theory of Plates and Shells	4	--	4	3	70	30	100	4
STNDM 2.2	Structural Stability	4	--	4	3	70	30	100	4
STNDM 2.3	Finite Element Methods of Analysis	4	--	4	3	70	30	100	4
STNDM 2.4	Earthquake Engineering	4	--	4	3	70	30	100	4
STNDM 2.5	d) Disaster Management e) Soil Dynamics f) Environmental Impact Analysis	4	--	4	3	70	30	100	4
STNDM 2.6	d) Prestressed Concrete e) Hydraulic Structures f) Fire Resistant design of Structures	4	--	4	3	70	30	100	4
STNDM 2.7	Repair and Rehabilitation of Structures	--	3	3	Viva	50	50	100	2
STNDM 2.8	Advanced Design of Structures		3	3	Viva	50	50	100	2
Total		**24**	**6**	**30**		**520**	**280**	**800**	**28**

III and IV SEMESTERS

Code No	Course title	Scheme of Examination	Total Marks	Credits
STNDM3.1	Dissertation (Preliminary)	Viva-voce	**100**	**10**
STNDM4.1	Dissertation (Final)	Defence and Viva-voce	**100**	**14**

M TECH. (STRUCTURAL ENGINEERING and NATURAL DISASTER MANAGEMENT)

Syllabus

(with effect from 2015-16 academic year)

I – SEMESTER

STNDM 1.1 : THEORY OF ELASTICITY

Plane Stress and Plane Strain: Components of stress, Strain, Hookes law, Stress and strain at a point. Plane stress, Plane strain, Equations of equilibrium, Boundary conditions, Compatibility equations stress foundation.

Two Dimensional Problems in Rectangular Coordinates: Solution by polynomials, Saint Vanant's principle determination of displacements, Bending of cantilever loaded at the end, Bending of a beam by uniform load.

Two Dimensional Problem in Polar Coordinates: General equations of equilibrium, Stress function and equation of compatibility with zero body forces. Analysis of thick cylindrical shells with symmetrical leading about the axis, Pure bending of curves bars, Strain components in polar coordinates, Rotating disks.

Three Dimensional State of Stress: Differential equations of equilibrium – Boundary conditions for compatibility – Displacements – Equations of equilibrium in terms of displacements – Principle of superposition – Uniqueness of solution.

Torsion: Torsion of straight bars – St.-Venant solution – Stress function, Warp function – Elliptic cross section – Membrane analogy torsion of bar of narrow rectangular cross section.

Analysis of Stress and Strain in Three Dimensions: Introduction – Principal stresses, - Determination of principal stress – Stress invariants – Maximum sheering stress strain at point.

Text Book:
1.“Theory of Elasticity” by Timoshenko and Goodier, McGraw Hill Company.

References:
1.“Theory of Elasticity” by Sadhu Singh, Khanna publishers
2 “Applied Elasticity” by C.T. Wang.
3.“Advanced Strength of Materials” by Denhortog.

STNDM 1.2 – ADVANCED REINFORCED CONCRETE DESIGN

Deflection of Reinforced Concrete Beams and Slabs: Introduction, Short-term deflection of beams and slabs, Deflection due to imposed loads, Short-term deflection of beams due to applied loads, Calculation of deflection by IS 456, Deflection of continuous beams by IS 456, Deflection of slabs.

Estimation of Crack width in Reinforced Concrete Members: Introduction, Factors affecting crack width in beams, Mechanisms of flexural cracking, Calculation of crack width, Simple empirical method, Estimation of crack width in beams by IS 456, Shrinkage and thermal cracking.

Redistribution of Moments in Reinforced Concrete Beams: Introduction, Redistribution of moments in fixed beam, Positions of points of contraflexures, Conditions for moment redistribution, Final shape of redistributed bending moment diagram, Moment redistribution for a two-span continuous beam, Advantages and disadvantages of moment redistribution, Modification of clear distance between bars in beams (for limiting crack width) with redistribution, Moment-curvature (M - ψ), Relation of reinforced concrete sections.
Approximation Analysis of Grid Floors: Introduction, Analysis of flat grid floors, Analysis of rectangular grid floors by Timoshenko's plate theory. Analysis of grid by stiffness matrix method, Analysis of grid floors by equating joint deflections, Comparison of methods of analysis, Detailing of steel in flat grids.

Design of Flat Slabs: Introduction, Proportioning of Flat Slabs, Determination of Bending moment and Shear Force, Direct Design method, Equivalent Frame method, Slab Reinforcement.

Bunkers and Silos : Introduction, Design of Rectangular Bunkers, Design of Tension member, Design of Circular Bunker, Design of Silos.

Chimneys : Introduction, Design factors, Stresses due to Self Weight and Wind load, Stress in horizontal reinforcement, Temperature Stresses, Combined effect of Self Weight, Wind load and Temperature, Temperature stresses in Hoop(Horizontal) Reinforcement.

Design of Reinforced Concrete Members for Fire Resistance: Introduction, ISO 834 standard heating conditions, Grading or classifications, Effect of high temperature on steel and concrete, Effect of high temperatures on different types of structural members, Fire resistance by structural detailing from tabulated data, Analytical determination of the ultimate bending moment, Capacity of reinforced concrete beams under fire, Other considerations.

References:
1."Advanced Reinforced Concrete Design" by P.C. Varghese.
2."Reinforced Concrete" by Park & Paulay.

STNDM 1.3 MATRIX METHODS OF STRUCTURAL ANALYSIS

Introduction to Matrix methods: Introduction, coordinate systems, displacement and force transformation matrices, element and structure stiffness matrices, Element and structure flexibility matrices, equivalent joint loads, stiffness and flexibility approaches.

Matrix methods for beams: Analysis of beams, fixed and continuous beams by flexibility method. Analysis of beams, fixed and continuous beams by stiffness method.

Matrix methods for Plane truss problems: Analysis of 2-D trusses by flexibility method. Analysis of 2-D trusses by stiffness method

Matrix methods for Plane Frames: Analysis of 2-D frames by Flexibility matrix methods. Analysis of 2-D frames by Stiffness matrix methods.

References:
6.   Devdas Menon,"Advanced StructuralAnalysis", Narosa Publishing House, 2009.
7.   Asslam Kassimali,"Matrix Analysis of Structures", Brooks/Cole Publishing Co., USA, 1999.
8.   Analysis of Inderminate structures – C.K Wang 2. Matrix Analysis of framed Structures-W Weaver& Gere.
9.   G.S.Pandit, S.P.Gupta, "Matrix methods of Structural Analysis", Tata McGraw Hill Co..
10.   William Weaver, James M. Gere, "Matrix Analysis and Framed Structures", D. Van Nostrand Co., 1980.

STNDM 1.4 - INDUSTRIAL STRUCTURES

Plastic Analysis: Introduction, Limit analysis of steel structures, Mechanical properties of structural steel, Plastic hinge, Moment curvature relations, Limit load, Coplanar load, Upper lower bound theorems. Redistribution of moments continuous beams: Relevant or irrelevant mechanisms, Types of mechanisms method for performing moment check. Portal frame, Mechanisms, Combination of mechanisms, Moment check, Partial complete and over complete collapse.

Light gauge steel structures: Local buckling of thin sections, Post packing of thin elements, Light gauge steel columns and compression members, Form factor for columns and compression members, Stiffened compression elements, Multiple stiffened compression elements, Unstiffened compression elements effective length of light gauge steel compression members, Basic design stress, Allowable design stress, Light gauge steel beams, Laterally supported light gauge steel beams web crippling. Allowable design stress in beams, Beams subjected to combined axial end bending stress, connections.

Analysis of Communication Towers: Analysis of Transmission line Towers: Loads on towers, Sag (dip) and Tension in uniformly loaded conductors, Analysis of towers (analysis as coplanar

assembly), Design of members in towers, Design of foundation of towers.Design of Steel Chimneys for wind and gravity loads.

Design of gantry girder

References:
4.   "Plastic Analysis of Structures" by Beedle.
5.   "Design of Steel Structures" by Arya & Ajmani, Nemchand Publishers.
6.   "Comprehensive Design of Steel Structures", B.C.Punmia,Ashok Kumar Jain, Arun Kumar Jain, Laxmi   Publications (P) Ltd

STNDM 1.5 a ADVANCED FOUNDATION ENGINEERING

Introduction: Principles of Design of Foundations, Types of shear failures in foundation soils, Types of foundations, Design Loads, Basic Concepts of safe and allowable bearing capacity.Shallow Foundations

Bearing Capacity Analysis: Bearing capacity theories – Terzaghi, Meyerhof, Skempton, Hansen, Vesic and IS Methods, Bearing capacity evaluation from Standard Penetration test and Plate load test.

Settlement Analysis: Uniform and Differential Settlements, Elastic and Consolidation Settlements, Settlement analysis in cohesion less soils by Schemartmann and Hartman method, Penetration tests; Permissible settlements as per IS 1904-1978, causes of settlement, settlement Control.

Proportioning of footings: Isolated column footings, Strip, combined Footings and Strap Footing.

Raft Foundations: Bearing capacity of raft foundation, floating raft, Types of rafts, Beam on Elastic foundation and Conventional methods of Design, determination of modulus of subgrade reaction.

Deep Foundations : Pile Foundations: Types, load capacity- dynamic formulae, static formula; pile load tests- Vertical load test, lateral load test, Cyclic load test; settlement of piles and pile groups, negative skin friction on single pile and pile groups; laterally loaded piles - Broom's Analysis, IS Code method; Under reamed piles – Load capacity, design and construction.

Well Foundations: Types, Bearing Capacity of well foundations, Construction of pneumatic caissons, Tilts and Shifts: precautions, Remedial measures; Lateral stability analysis by Terzaghi's Method, Design aspects of Components of well foundation.

Foundations in Expansive Solis : Introduction, Identification of expansive soils, Swell potential and swelling pressure, Active depth, Foundation Problems, Foundation practices in expansive soils, Soil Replacement and 'CNS' concepts.

Foundations of Transmission Line Towers : Introduction, Necessary information, Forces on tower foundations, General design criteria, Choice and type of foundation, Design procedure.

Reference Books:
1.   Foundation Analysis and Design by J.E. Bowles, Mc Graw Hill Publishing Co.
2.   Foundation Design by W.C. Teng, John Wiley, New York.
3.   Analysis and Design of Substructures by Swami Saran, Oxford &IBH Publishing Co.
4.   Foundation Engineering by P.C. Vargheese, Prentice Hall of India
5.   Basic and Applied Soil Mechanics by Gopal Ranjan and A.S.R. Rao, New Age International Publications

STNDM 1.5 b) WIND ANALYSIS AND DESIGN OF TALL STRUCTURES

Introduction: Basic wind speed, Design wind speed, Design wind pressure, offshore wind velocity, wind pressures and forces in buildings/structures, External pressure coefficients for various roofs, dynamic effects.

Lateral load Analysis of Multistory Building Frames : Analysis of Multistory Building Frames for lateral loads, Cantilever method, Portal method and Factor method.

Design of Shear Wall: Introduction, Types of shear walls, Behaviour of cantilever wall with rectangular cross-section, flange cantilever shear walls, Moment-Axial load interaction for shear wall section, Interaction of shear walls and rigid joined frames, Shear walls with openings, Coupled shear walls.

Design of Chimneys (RCC): Introduction, Wind pressure, Stress in chimney shaft due to self weight and wind, Stress in horizontal reinforcement due to wind shear, Stresses due to temperature difference. Design of RC chimney.

Bunkers and Silos: Introduction, Differences between bunker and silo, Design of square or rectangular bunkers, Design of circular bunkers, Design of silos, Silos for storage of cement.

Multistory Building Frames: Analysis of multistory frames, Method of substitute frames,Bending moments in beams and columns.

References:
6.   "Reinforced Concrete Structures" by Park, R. & Paulay, T.
7.   "Advanced Reinforced Concrete Design",by N.Krishna Raju
8.   "Reinforced Concrete Structures" by Punmia, Jain & Jain.
9.   "Tall Chimneys" by Manohar, S.N.
10.   "Design of Steel Structures"by N.Subramanian

STNDM 1.5 c) EXPERIMENTAL STRESS ANALYSIS

Analysis of Stress, strain, Stress- Strain relation and theories of failure

Electrical Resistance Strain Gauges: Principle of operation and requirements, Types and their uses, Materials for strain gauge. Calibration and temperature compensation, cross sensitivity, Rosette analysis, Wheatstone bridge and potentiometer circuits for static and dynamic strain measurements, strain indicators.

Photoelasticity: Two dimensional photo elasticity, Concept of light – photoelastic effects, stress optic law, Interpretation of fringe pattern, Compensation and separation techniques, Photo elastic materials. Introduction to three dimensional photo elasticity.

Brittle Coating And Moire Methods : Introduction to Moire techniques, brittle coating methods and holography.

Text Books
3.   "Experimental Stress Analysis", Srinath, L.S., Raghava, M.R., Lingaiah, K., Garagesha, G., Pant B., and Ramachandra, K., , Tata McGraw-Hill, New Delhi, 1984.
4.   Dally, J.W., and Riley, W.F., "Experimental Stress Analysis", McGraw-Hill Inc

STNDM 1.6 a) ADVANCED CONCRETE TECHNOLOGY

Durability of concrete and concrete construction: Durability concept, pore structure and transport processes, reinforcement corrosion, fire resistance, frost damage, sulphate attack, alkali silica reaction, delayed ettringite formation, methods of providing durable concrete, short-term tests to assess long-term behaviour.

Mix design: Review of methods and philosophies of IS, BS and ACI methods, mix design for special purposes. Acceptance criteria for compressive strength of concrete

Special concretes: Lightweight concrete, autoclaved aerated concrete, no-fines concrete, lightweight aggregate concrete and foamed concrete, High strength concrete, refractory concrete, high density and radiation-shielding concrete, polymer concrete, fibre-reinforced concrete, mortars, renders, recycled concrete, Ferro Cement, Self Compacting Concrete.

Special processes and technology for particular types of structure: Sprayed concrete, underwater concrete, grouts, grouting and grouted concrete, mass concrete, slip form construction, pumped concrete, concrete for liquid retaining structures, vacuum process, concrete coatings and surface treatments.

Test methods: Analysis of fresh concrete, Accelerated testing methods, Tests on hardened concrete, Core cutting and testing, partially destructive testing, Non-destructive testing of concrete structures

References:
4.   Properties of Concrete, A.M.Neville, Longman 1995.
5.   Concrete micro-structure, Properties and Materials, P.K.Mehta, J.M.Monteiro, Printice Hall INC & McGraw hill, USA.
6.   Concrete Technology Theory and Practice, M.S.Shetty, S.Chand & Company Ltd, New Delhi.

STNDM 1.6 b) BRIDGE ENGINEERING

Introduction to bridge engineering. Historical background of bridges and types. Bridge aesthetics and proportioning. Design process. Review of applicable design codes. Loads on bridges and force distribution. Bridge geometry.

Analysis and design of Slab Bridge, Skew slab bridge.

Analysis and design of T-beam bridge: Deck slab considering IRC loads, longitudinal girders(Interior, Exterior), Cross girder.

Analysis and design of prestressed concrete girder and box girder bridges considering only primary torsion, Design of end block.

Bridge Bearing: Types of bearings, Rocker bearing, Elastomeric bearing.

Text books:
3.   "Essentials of Bridge Engineering", D. Jhonson Victor, Oxford University Press.
4.   "Design of Bridges", N.Krishna Raju, Oxford & IBH Publishing Co.Pvt.Ltd, New Delhi

STNDM 1.6 c) STRUCTURAL DYNAMICS

One Degree Systems: Undamped systems, Various forcing functions damped systems, Response to pulsating force, Support motion.

Lumped Mass Multidegree System: Direct determination of natural frequencies, Characteristic shapes, Stodola-Vianelle method, Modified Rayleigh-Ritz method, Lagrange's equation, Model analysis of multi degree systems, Multistorey rigid frames subjected to lateral loads, Damping in multi degree systems.

Structures with distributed mass and load, Single span beams, Normal modes of vibration, Forced vibrations of beams, Beams with variable cross-section and mass.

Approximate design methods, Idealized system, Transformation factors, Dynamic reactions response calculations, Design example (RC beam, Steel beam and RC slab), Approximate design of multi degree systems.

Matrix Approach: Coordinates and lumped masses, Consistent mass matrix, Undamped force vibration of a system with one degree freedom, Response of single degree freedom undamped system, Viscous damped vibration of a single degree freedom system, Undamped vibration of multi degree freedom system, Orthogonality of natural nodes, Normal coordinates.

Books:
1."Structural Dynamics" by John M. Biggs.
2."Structural Analysis" by A. Ghali & A.M. Neville.

STNDM 1.7 COMPUTER APPLICATIONS IN STRUCTURAL ENGINEERING

Application of software's in Structural Engineering (by using STAAD Pro,ETABS, STRAP, STRUDS etc) for the following problems.
1.   Analysis and Design of Beams.
2.   Analysis and Design of Footings.
3.   Analysis and Design of Trusses.
4.   Analysis and Design of Two Dimensional Frames.
5.   Analysis and Design of Three Dimensional Frames.
6.   Analysis and Design of Water Tanks.
7.   Analysis and Design of Steel Members.
8.   Implementation of Concepts of FEM using a Computer Language.

STNDM 1.8 DESIGN OF STRUCTURES (VIVA-VOCE)

On Any **THREE** of the following:

1. Design of Folded Plates
2. Elevated Service Reservoirs
3. Retaining walls
4. Grid floor
5. Flat slab
6. Pressed steel tank
7. Buried pipes

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II – SEMESTER

STNDM 2.1 THEORY OF PLATES AND SHELLS

Bending of Long Rectangular Plates to a Cylindrical Surface: Differential equation for cylindrical bending of plates – Uniformly leaded rectangular plates with simple supported edges and with built in edges. Pure bending of plates slopes – Curvatures of bent plates – Relations between bending moments and curvature – Particular cases – Strain energy in pure bending – Limitations.

Symmetrical Bending of Circular Plates: Differential equation – Boundary conditions. Simply supported rectangular plates under sinusoidal loading – Naviers solution and its application to concentrated load – Levy's solution for uniformly distributed load or hydrostatic pressure – Bending of rectangular plates by moments distributed along the edges – Differential equation of rectangular plate within plane and lateral forces.

Membrane analysis:
a) Shells of revolution (axi-symmetrical loading), Spherical shells, Conical shells, Elliptical shell of revolution, Torus, Hyperboloid of revolution of one sheet, Shells of uniform strength membrane deformation.

b) Membrane analysis of shells of translation, Circular cylinder, Diretrix, Parabola, Cycloid, Catenary and Membrane deformations.

c) Membrane analysis of shells of general shape: Anticlastic, Synclastic shells, Hyperbolic paraboloid, Candella shells, Conoid, Elliptic paraboloid, Rotational paraboloid.

Bending analysis of cylindrical shell: Beam method, Schorer method, Finsterwalder method. Classification analysis.

Text Books:
1. "Theory of Plates and Shells" by Timoshenko, S. and Wernewsky-Kriegar.
References:
1. "Design of Reinforced Concrete Shells and Folded Plates" by P.C.Varghese
2. "Stresses in Shells" by Flugge.
3. "Design and Construction of Shells" by Ramaswamy, G.S.

STNDM 2.2 STRUCTURAL STABILITY

Buckling of Columns: Method of neutral equilibrium, Critical load of the Euler column, Linear column theory – An eigen value problem, Effective length concept, Higher order differential equation for columns initially bent columns, Effect of shear stress on buckling, eccentrically loaded columns, beam columns (Beam columns with concreted lateral load, distributed, load end moment), Inelastic buckling of columns, Double modulus theory, Tangent modulus theory, Shanley theory of inelastic column behaviour.

Approximate Methods of Analysis: Conservation of energy principles, Calculation of critical loads using approximate deflection curve, Principle of stationary potential energy, Raleigh-Ritz method, Buckling load of column with variable cross-section, Galerkin's method, Calculation of critical load by finite differences, Unevenly spaced pivot points, Matrix stiffness method, Effect of axial load on bending stiffness-slope deflection equations, Buckling of column loaded along the length using energy methods.

Buckling of Frames: Modes of buckling, Critical load of a simple frame using neutral equilibrium, Slope deflection equations and matrix analysis. Lateral buckling of cantilever and simply supported beams of rectangular and I-sections and use of energy method and finite differences.

Buckling of Plates: Differential equation, Strain energy of bending, Critical load, Finite difference approach inelastic buckling of plates.

Matrix approach for Frames: Criterion for determination of critical loads, Stiffness influence coefficients for members without axial load, Derivation of stability functions, Problem involving Non-sways, Modified stiffness of beams, Frames with sway, Multi-bar frames.

References:
1. "Principles of Structural Stability Theory" by Alexander Chajes.
2. "Theory of Elasticity Stability" by Timoshenko and Gere.

STNDM 2.3 FINITE ELEMENT METHODS OF ANALYSIS

Introduction: A brief history of F.E.M. Need of the method, Review of basic principles of solid mechanics- Equations of equilibrium, Boundary conditions, Compatibility, Strain displacement relations, Constitutive relationship in matrix form, plane stress & plane strain and axisymmetric bodies of revolution with axi-symmetric loading, Energy principles - Raleigh - Ritz method of functional approximation.

Theory relating to the formulation of the finite element method, Coordinate system (local and global), generalized coordinates, Concept of the element, Various element shapes, Discretisation of a structure, Mesh refinement Vs. Higher order element, Interconnections at nodes of displacement models, inter element compatibility, -shape functions.

Basic component – One dimensional FEM single bar element, Beam element : Derivation of stiffness matrix, Assembly of stiffness, Matrix boundary conditions, shape functions for 1 D elements, Initial strain and temperature effects, and trusses under axial forces.

Two dimensional FEM**:** Different types of elements for plane stress and plane strain analysis – Displacement models Generation of element stiffness and nodal load matrices –static condensation.

Isoperimetric representation and its formulation for 2d analysis. Formulation of 4-noded and 8-noded isoparametric quadrilateral elements – Lagrangian elements-serendipity elements.

References :

5.   Introduction to Finite element Method by Tirupathi chandra Patla and Belugundu
6.   C.S.Krishnamoorthy, (2002), Finite Element Analysis, Tata McGraw Hill Publishing Co. Ltd.
7.   The Finite Element Method in Engineering Science" by Zienkiewicz, P., McGraw Hill, 1971.
8.   Introduction to Finite Element Method by Desai,C.S.and Abel, J.F.,Van Nostrand, 1972.

STNDM 2.4 EARTHQUAKE ENGINEERING

One Degree Systems: Undamped systems, Various forcing functions damped systems, Response to pulsating force, Support motion. Lumped Mass Multidegree System: Direct determination of natural frequencies, Characteristic shapes, Stodola-Vianelle method, Modified Rayleigh-Ritz method, Lagrange's equation, Model analysis of multi degree systems, Multistorey rigid frames subjected to lateral loads, Damping in multi degree systems.

Matrix Approach: Coordinates and lumped masses, Consistent mass matrix, Undamped force vibration of a system with one degree freedom, Response of single degree freedom undamped system, Viscous damped vibration of a single degree freedom system, Undamped vibration of multi degree freedom system, Orthogonality of natural nodes, Normal coordinates.

Earthquakes, Epicenter, Hypocenter and earthquake waves, Measurement of ground motion, Seismic regions, Intensity and Isoseismals of an earthquake, Magnitude and energy of an earthquake, Consequences of earthquakes, Seismic zoning. Earthquake Response of Linear Systems: Earthquake excitation, Equation of motion, Response quantities, Response history, Response spectrum concept, Deformation, Pseudo-velocity, and Pseudo-acceleration, Response spectra, Peak structural response from the response spectrum, Response spectrum characteristics, Elastic design spectrum, Comparison of design and response spectra, Distinction between design and response spectra.

Earthquake analysis of Multistorey buildings: By seismic coefficient method and Response spectrum method, Base shear, Fundamental period of buildings, Distribution of forces along the height

Earthquake analysis of Water towers: Introduction, Behaviour under earthquake loads, Design features, Water tower as a rigid jointed space frame, Hydrodynamic pressures in tanks.

Earthquake analysis of Stack like structures: Introduction, Fundamental period of vibration, Dynamic bending moment, Shear diagram

Earthquake analysis of dams: Hydrodynamic pressures on dams, Zanger's method, Vertical component of reservoir load, Concrete or masonry gravity dams

Books:
7.   "Structural Dynamics" by John M. Biggs.
8.   "Structural Analysis" by A. Ghali & A.M. Neville.
9.   "Elements of Earthquake Engineering" by Jaikrishna and Chandrasekharan, Saritha Prakasham, Meerut.
10.   "Dynamics of Structures, Theory and Applications to Earthquake Engineering" by Anil K. Chopra, Prentice Hall of India.
11.   "Earthquake resistant design of structures" by S.K.Duggal, Oxford University Press.
12.   "Earthquake resistant design of structures" by Pankaj Agarwal and Manish Shrikhande, Prentice Hall of India Pvt. Ltd.

STNDM 2.5 a) DISASTER MANAGEMENT

Introduction, Disaster Management ,Hazards and Disasters: Earthquake Risk Management, Tsunami Risk Reduction, Flood Risk Management, Cyclone Risk Management, Drought Risk Management, Post-tsunami Hazards along the Indian Coast.

 Risk and Vulnerability: Building Codes and Land Use Planning, Social Vulnerability, Macro-economic Management and Sustainable Development ,Environmental Vulnerability and Disaster Risk Reduction ,Climate Change Risk Reduction, Financial Management of Disaster – related Economic Losses.

Disaster Reduction Technology: Implementation Technology for Disaster Reduction, Disaster Management for Infrastructure, Geospatial Information in Agricultural Drought Assessment and Monitoring, Multimedia Technology in Disaster risk Management Training, Transferable Indigenous Knowledge in Disaster Reduction.

Education and Community: Education in Disaster Risk Reduction, Essential of School Disaster Education, Community Capacity and Disaster Resilience, Community-based   Disaster Recovery, Community-based Disaster Management and Social Capital, Designing Resilience.

Crosscutting Issues: Disaster, Environment and Development,   Impact   of   Disasters   on Poverty and Deprivation, Climate Change adaptation and Human Health, Exposure, Health Hazards and Environmental Risk. Hydro-meteorological disasters and Agriculture, Forest Management and Disaster Risk Reduction.

Rural Livelihood and Disaster Risk Reduction, Essentials of Urban Disaster Risk Reduction, Institutional Capacity in Disaster Management, Corporate Sector and Disaster Risk Reduction, Essentials of Pre-disaster Recovery Planning, Experiences of Disaster Risk Reduction .

Books:
1.   Disaster Management ,R.B.Singh, Rawat Publications
2.   Natural Disaster Management ,Jon Ingleton
3.   Disaster Management, Rajib Shaw and RR Krishnamurthy, Universities Press, Hyderabad.

STNDM 2.5 b) SOIL DYNAMICS

Theory of Vibration: Free and forced vibrations with and without damping for single mass system with single degree freedom, Logarithmic Decrement and Damping Ratio, Principles of Design of Vibration measuring Devices, Transmissibility of force, vibrations of Two degree freedom system, vibrations of Systems under transient loads.

Natural frequency of foundation soil system- Barkan's Method, Pressure Bulb Concept, Pauw's Analogy, Tschebetorioff's concept of reduced natural Frequency

Dynamic Soil Properties: Tests for determination of dynamic soil properties - Cyclic Plate load test, Block vibration test, Up Hole, down Hole and Cross Hole wave Propagation tests, Hammer Test, Resonant Column Test, Seismic Reflection and Refraction tests.

Design of Machine Foundation: Types of Machine Foundations, design criteria, Degrees of Freedom of Block foundation, Analysis of Block foundations under sliding, rocking, yawing and Coupled motions, Design Aspects and Construction details of foundations for reciprocating and Impact, vibration isolation: active and passive isolation, vibration isolation materials.

References:
1.   Soil Dynamics by Shamsher Prakash, Shamsher Prakash Foundation
2.   Hand Book of Machine Foundations by P. Srinivasulu and C.V. Vaidyanathan, Tata Mc Graw Hill Book Co.
3.   Dynamics of Bases and Foundation by Barken, Mc Graw Hill Book Co.
4.   Vibration of soil and Foundation by Richart F.E., Hall J.A., Woodes R.E., Prentice Hall

STNDM 2.5 c) ENVIRONMENTAL IMPACT ANALYSIS

Introduction to EIA: Definition, Concepts, Types, Limitations, components of EIA process, settings – public participation, public hearing. Methodologies: background information, interaction matrix methodologies, network methodologies etc, environmental setting- various factors, documentation and selection process, environmental indices and indicators for describing affected environment.

EIA notification by Ministry of Environment and Forest (Govt. of India): Provisions in the EIA notification, Categorization of Industries for seeking environmental clearance from concerned authorities, procedure for environmental clearance, procedure for conducting environmental impact assessment report, Rapid and Comprehensive EIA, general structure of EIA document, Environmental management plan, post environmental monitoring. Case studies in EIA.

Prediction and assessment of impact for air and noise environment: Basic information of air quality, identification of type and quantity of air pollutant, existing air quality and air quality standards, impact prediction and assessment, mitigation. Basic information of noise, existing noise levels and standards, prediction of noise levels and assessment of impact, mitigations.

Prediction and assessment of impact for water and soil environment: Basic information of water quality (Surface water and groundwater), water quality standards, identification of impact, prediction of impact and assessment, mitigations. Background information of soil environment, soil and groundwater standards, prediction and assessment of impact for groundwater and soil, mitigations.

Prediction and assessment of impact on cultural and socioeconomic environment: Basic information on cultural resources, rules and regulations for cultural resources like archaeological, historical structures, Cultural system, prediction and assessment of impact, mitigations. Basic information of socio-economic environment, description of existing socio-economic environment, prediction and assessment of impact, mitigation, resettlement and rehabilitation.

References :
1.   Environmental Impact Assessment, Canter R.L., Mc Graw Hill International Edition,1997.
2.   Environmental Impact Analysis Handbook, John G. Rau and David C. Wooten (Ed), McGraw Hill Book
3.   Environmental Impact Assessment Methodologies by Y Anjaneyulu, and Valli Manikkam, BSP Books PVT Ltd
4.   Environmental Impact Assessment by Anji Reddy, BSP Books PVT Ltd

STNDM 2.6 a) - PRESTRESSED CONCRETE

Introduction: Basic concepts of prestressing need for high strength steel and concrete, advantages of prestressed concrete. Materials for prestressed concrete, high strength concrete and high strength steel.

Prestressing systems and losses of prestress: (1) Freyssinet Anchorage System (2) Gifford Udall System (3) Magnel-Blaton System, Tensioning devices, anchoring devices. (d) Pretensioning and Post tensioning. Prestressing losses, Elastic shortening, loss due to shrinkage, loss due to creep, loss due to friction, loss due to slip etc. I.S.code provisions.

Analysis of prestressed Concrete Beams: Assumptions, Analysis of prestress, Resultant stresses at a section, pressure or thrust line, concept of load balancing, cable profile, kern distance, stress in tendons as per IS 1343, cracking moment.

Shear and Torsional Resistance of Prestressed Concrete Members: Shear and Principal Stresses, Ultimate Shear Resistance of Prestressed Concrete Members, Design of Shear Reinforcements, Prestressed Concrete members In Torsion, Design of Reinforcements for Torsion, Shear and Bending

Transfer of prestress in Pretensioned members: Transmission length, bond stress, Transverse tensile stress, End Zone reinforcement, flexural bond stress, I.S. Code Provisions.

Anchorage zone in post tensioned members: Introduction, stress distribution in End block, Investigation on Anchorage Zone Stresses- Magnel's method, Guyon's method of approach of analysis of end block (Not more than 2 cables).

Deflection of Prestressed Concrete Members: Importance of Control of Deflections, Factors Influencing Deflections, Short-Term Deflection of Uncracked members, Prediction of Long Time Deflections, Deflection of Cracked Members, Requirements of various Codes of Practice.

Text Book:
   1. Prestressed Concrete by N.Krishna Raju.
References:
4.   Prestressed Concrete by N.Rajagopalan.
5.   Prestressed Concrete by P. Dayaratnam.
6.   Design of Prestressed Concrete Structures by T.Y. Lin and Ned. H. Burns.

STNDM 2.6 b) HYDRAULIC STRUCTURES

Dams: Types, Choice of type of dam, Forces acting on dams, Requirements of stability, Causes of failure.

Gravity dams: Non-overflow and overflow types, Modes of failure and criteria for structural stability of gravity dams, Design of gravity dam, Single step and multistep design, Cracks and joints in a gravity dam, Foundation treatment for gravity dams, Stress concentration around openings in dams, gravity dams subjected to earthquakes.

Spillways: Different types of spillways and their design principles, Energy dissipation below spillways, Use of hydraulic jump as energy dissipater and design of stilling basins, Types of spillway gates.

Arch dams: Types, loads on arch dams, Cylinder theory – Constant radius, Constant angle, Variable radius types, and Principles of elastic theory and Trial load method of analysis.

Buttress dams: Components, Advantages and Disadvantages, Types, Forces, Theory of buttress design, Buttress spacing and buttress construction details.

Earth dams: Types of earth dams, Methods of construction, Causes of failure of earth dam, Design criteria for earth dams, Selecting a suitable section for an earth dam, Requirements of safety, Seepage, Construction of seepage line for different conditions, Seepage control methods, Stability analysis for different conditions, Factor of safety against foundation shear, Details of method of construction of earth dams, Maintenance and treatment of common troubles in earth dams.

Appurtenance works: Design principles of various types of crest gates, Stilling basins, and drainage galleries.Water hammer analysis and design of surge tanks, Penstocks, Draft tubes and Scroll casing.

References :
1.   Theory and Design of Irrigation Structures Vol. I & II, 7th edition, Varshney, R.S., S.C. Gupta and Gupta, R.L.,Nem Chand & Brothers.
2.   Irrigation: Practice and Design – Vols. II & III, Khushalani, K.B. and M. Khushalani, Oxford of IBH Publishing Co
3.   Irrigation and Hydraulic structures, Garg, S.K., Khanna Publishers.
4.   Engineering for Dams – Vols. I, II & III, Creager, W.P, J.D. Justin and J. Hinds,John Wiley & Sons.
5.   Hand Book of Applied Hydraulics, Davis, C.V. and K.E.Sorensen, Third Edition, McGraw-Hill Book Co.

STNDM 2.6 c) FIRE RESISTANT DESIGN OF STRUCTURES

Materials properties in fire, Classification systems for high temperature concretes.

Design of structures at normal temperatures – Loads, Structural analysis, Material properties, Probability of failures.

Design of structures under fire conditions – Design equate loads for fire design, Structural analysis. Design of individual members exposed to fire – Tension members – Compression members – Beams.

Design structural assemblies exposed to fire – Frames – Redundancy – Disproportionate collapse – Continuity – Plastic design.

Mechanical properties steel at elevated temperatures. Components of strain, Thermal strain, Creep strain, Stress-related strain.

Design of steel buildings exposed to fire – Multistorey steel framed buildings.

Concrete structures – Behaviour of concrete structures in fire. High strength, lightweight, Fibre reinforced and prestressed concrete. External reinforcing.

Fire resistance ratings, Verification methods, Generic ratings, Projection systems.

Mechanical properties of concrete at elevated temperatures. Test methods, Components of strain, Thermal strain, Stress-related strain.

Design of concrete members exposed to fire member design, Simply supported slabs and beams shear strength, Continuous slabs and beams axial restraint, Columns, Walls and Frames.

References:
1.   "Fire Safety in Buildings" by Jain, V.K.
2.   "Structural Design for Fire Safety" by Andrew H. Buchanan.

STNDM 2.7 REPAIR AND REHABILITATION OF STRUCTURES

Materials: Construction chemicals, Mineral admixtures, Composites, Fibre reinforced concrete, High performance concrete, Polymer-impregnated concrete.

Techniques to Test the Existing Strengths: Destructive and non-destructive tests on concrete.

Repairs of Multi-storey Structures: Cracks in concrete, Possible damages to the structural element beams, Slab, Column, Footing, etc., Repairing techniques like Jack Chu, Grouting, External pre-stressing, Use of chemical admixtures, Repairs to the fire damaged structure.

Repairs to Masonry Structures & Temples: Damages to masonry structures – Repairing techniques, Damages to temples – Repairing techniques.

Foundation Problems: Settlement of soils – Repairs, Sinking of piles – Repairs.

Corrosion of Reinforcement: Preventive measures – Coatings – Use of SBR modified cementitious mortar, Epoxy resin mortar, Acrylic modified cementitious mortar, Flowing concrete.

Temporary Structures: Need for temporary structures under any Hazard, Various temporary structures, Case-studies.

Case Studies: At least 2 case studies per each student.

References:
5.   "Renovation of Structures" by Perkins.
6.   "Repairs of Fire Damaged Structures" by Jagadish, R.
7.   "Forensic Engineering" by Raikar, R.N.
8.   "Deterioration, Maintenance and Repair of Structures" by Johnson, McGraw Hill.

STNDM 2.8 ADVANCED DESIGN OF STRUCTURES (VIVA-VOCE)

On Any **THREE** of the following:

1. Design of blast resistant structures
2. Design of berth structures
3. Design of Quay Walls
4. Pre-engineered buildings
5. Bow string girder bridge
6. Balanced cantilever bridge
7. Raft design
8. Design of Piles and pile caps

Department Of Civil Engineering
M TECH. (ENVIRONMENTAL ENGINEERING AND MANAGEMENT)
Scheme of Instruction and Examination
(with effect from 2015-16 academic year)

I – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
EEM1.1	Numerical Methods and Statistical Analysis	4	--	4	3	70	30	100	4
EEM1.2	Environmental Chemistry	4	--	4	3	70	30	100	4
EEM1.3	Environmental Microbiology and Sanitation	4	--	4	3	70	30	100	4
EEM1.4	Environmental Hydraulics	4	--	4	3	70	30	100	4
EEM1.5	a)Environmental Impact Analysis b) Watershed Management c)Ecological and Ecosystem Engineering	4	--	4	3	70	30	100	4
EEM1.6	a) Remote sensing & GIS Applications b)Environmental Legislation c) Occupational Health, Safety and Hygiene	4	--	4	3	70	30	100	4
EEM1.7	Environmental Engineering Lab	--	3	3	Viva	50	50	100	2
EEM1.8	Case Studies		3	3	Viva	50	50	100	2
Total		**24**	**6**	**30**		**520**	**280**	**800**	**28**

II – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
EEM2.1	Advanced Water and Wastewater Treatment	4	--	4	3	70	30	100	4
EEM2.2	Air Pollution and Control	4	--	4	3	70	30	100	4
EEM2.3	Solid and Hazardous Waste Management	4	--	4	3	70	30	100	4
EEM2.4	Industrial Wastewater Treatment	4	--	4	3	70	30	100	4
EEM2.5	a)Disaster Management b)Agricultural Pollution and Control c) Environmental Biotechnology	4	--	4	3	70	30	100	4
EEM2.6	a) Energy, Environment and Sustainability b) Surface and Groundwater modelling c) Plumbing Services and Maintenance	4	--	4	3	70	30	100	4
EEM2.7	Environmental Process Design and Drawing	--	3	3	Viva	50	50	100	2
EEM2.8	Seminar		3	3	Viva	50	50	100	2
Total		**24**	**6**	**30**		**520**	**280**	**800**	**28**

III and IV SEMESTERS

Code No	Course title	Scheme of Examination	Total Marks	Credits
EEM3.1	Dissertation (Preliminary)	Viva-voce	**100**	**10**
EEM4.1	Dissertation (Final)	Defence and Viva-voce	**100**	**14**

Department Of Civil Engineering

M TECH. (ENVIRONMENTAL ENGINEERING AND MANAGEMENT)

Syllabus

(with effect from 2015-16 academic year)

I – SEMESTER

EEM 1.1 : NUMERICAL METHODS AND STATISTICAL ANALYSIS

Linear system – Gaussian elimination and Gauss – Jordan methods – Matrix inversion – Gauss Seidel method – Non-linear equations – Regula-falsi and Newton- Raphson methods – interpolation – Newton's and Lagrange's interpolation

Linear Programming – Graphical and Simplex methods – Measures of central tendency, dispersion, Skewness and Kurtosis – Probability – conditional probability – Bayes' theorem

Numerical solutions of ordinary differential equations – Introduction to initial and boundary value problems – Numerical solutions of ordinary differential equations : Taylor's series, Euler's method, Modified Euler's method, Runge- Kutta methods (secomd and fourth orders) – Predictor-

Random variable – two dimensional random variables – standard probability distributions – Binomial Poisson and normal distributions - moment generating function

Sampling distributions – confidence interval estimation of population parameters – testing of hypotheses – Large sample tests for mean and proportion – t-test, F-test and Chi-square test – curve fitting-method of least squares

Regression and correlation – rank correlation – multiple and partial correlation – analysis of variance-one way and two way classifications – experimental design – Latin square design – Time series analysis.

References :
1.   Probability and Statistics for Engineers by Richard A. Johnson
2.   Numerical methods by S. Armugan, A. Thangapandi Issac, A. Someswaranadham

EEM 1.2. ENVIRONMENTAL CHEMISTRY

(Basic concepts of the following branches of the chemistry as applicable to the Environmental Engineering)

Quantitative, Qualitative and physical chemistry : Basic concepts of physical chemistry, Gas laws, Laws of Mass action, Common Ion Effect, Solutions, Vapour pressures of liquids, Binary Mixtures, Solutions of solids in Liquids, Oxidation – Reduction potentials, Ionization, Solubility products, Basics of colloidal chemistry- adsorption and absorption – principles

Equilibrium Chemistry : Equilibrium constants and Calculations, Le-Chatelier Principle, Transport and transformation of chemicals – Photo catalysis - Soil chemistry - acid-base and ion-exchange reactions in soil - salt affected soil and its remediation

Organic Chemistry: Properties of Organic Compounds, Sources of Organic Compounds, Isomerism, Types of Organic Compounds, Aliphatic, Aromatic and Heterocyclic. – Principles of green chemistry.

Biochemistry : Enzymes, factors affecting the action of Enzymes, (co-enzymes or cofactors, Temperature, pH, Micro and Macro mutants), Proteins, carbohydrates and fats.

UV visible spectroscopy: Basic principles – application – Flame Photometry - Atomic absorption spectroscopy – Principles – applications, Gas chromatograph and HPLC – Principles and applications.

Nuclear Chemistry : Atomic Structure, Electron orbits, Neutron, Proton, Nuclear structure, Nomenclature of Isotopes, stable and radioactive nucleoids, Nature of Radiation, Energy of Radiation, Units of Radioactivity, half life, α, γ and neutron induced reaction, nuclear fission and fusion.

Text Book :
1.   Chemistry for Environmental Engineering and Science, C.N. Sawyer, P.L. McCarty and G.F. Parkin, Tata McGraw-Hill publication.
2.   Environmental Chemistry by AK De, Wiley Publications

EEM 1.3. ENVIRONMENTAL MICROBIOLOGY AND SANITATION

Introduction : Microorganisms - classification, prokaryotic and eukaryotic cells, structure, characteristics, nucleic acids, DNA and RNA, replication. Recombinant DNA - Genetic Engineering.

Metabolism Of Microorganisms :Environmental factors, nutrition and metabolism, growth phases, enzymes, carbohydrate, protein, lipids metabolism, respiration, fermentation, Glycolysis, Kreb's cycle, Hexose monophosphate pathway, significance of energetic

Microbiology Of Drinking Water : Distribution of microorganisms, indicator organisms, coliforms - fecal coliforms - E.coli, Streptococcus fecalis and Clostridium welchii, differentiation of coliforms - significance - MPN index, M.F. technique, standards. Virus-concentration techniques. Algae in water supplies - problems and control.

Microbiology Of Wastewater Treatment : Biodegradation of toxic pollutants - alpha oxidation ,beta oxidation, electron transport system and oxidative phosphorylation mechanism, Microbiology of biological treatment process

Aquatic Microbiology : Ecotoxicology - toxicants and toxicity - factors influencing toxicity, effects, acute, chronic, concentration response relationships, test organismns, toxicity testing bioconcentration - bioaccumulation - bio-magnification - bioassay - biomonitoring.

Sanitation : Industrial sanitation : Schools, Public Buildings, Hospitals, Eating establishments, Swimming pools – Study of factors like Light, Heat, Ventilation, Plumbing fixtures, Cleanliness and maintenance and comfort..

Rural Sanitation : Population habits and environmental conditions, problems of water supply and sanitation aspects, low cost excreta disposal systems. Rural sanitation improvement schemes.

References :
1.   Microbiology for sanitary engineers by Mckinney
2.   Microbiology for Scientists and Engineers by Grady & Grady.
3.   Microbiology by Pelzer, Ecschan & N R Kreig. Tata McGraw Hill Publishing Company Limited.
4.   Municipal and Rural sanitation by Victor Ehalers & Earnest W Steel

EEM 1.4. ENVIRONMENTAL HYDRAULICS

Hydrology: Statistical analysis of Hydrological Data -, Intensity–Duration frequency Curves. Hydraulics of groundwater flow: Non–equilibrium flow, Yield estimations, Interferences Infiltration galleries, ground water recharge

Transportation and distribution of water: Storage capacity, Pumping of Water, Design and selection of economical diameter of pumping main. Distribution of Water - Pressure and capacity requirements of distribution system, Analysis of networks, Appurtenances in a distribution layout, detection and prevention of leakage mains.

Hydraulics of Sewers: Design of sewers in full and partial flow conditions, Flow at Sewer transitions, Sewage pumping. Open channel flow–design of open channel flow sections.

Transport phenomenon – diffusion – dispersion – advection – adsorption - conservative and non-conservative pollutants. Governing Equations for flow and transport in surface and subsurface waters-chemical and biological process models-simplified models for lakes, streams, and estuaries.

Modelling of the transport phenomenon: complexity - coupled and uncoupled models – linear and nonlinear models - Solution techniques – calibration. Numerical models: FDM, FEM and Finite volume techniques - explicit vs. implicit methods - numerical errors. Different types of Stream quality modeling and Groundwater transport modeling.

References :
1.   Water and waste water Engineering by Fair Gayer and Okun
2.   Engineering Hydrology by K. Subramanya, Tata McGraw-Hill Education
3.   Hydrodynamics of transport for water quality modeling by Martin, L.J. and McCucheon, S.C, Lewis Publishers.
4.   Groundwater by Freeze, R.A. and Cherry. J.A. Prentice Hall,
5.   Groundwater Hydrology by Todd, Wiley Publications

EEM 1.5 (a) ENVIRONMENTAL IMPACT ASSESSMENT AND MANAGEMENT

Introduction to EIA**:** Definition, Concepts, Types, Limitations, components of EIA process, settings – public participation, public hearing. Methodologies**:** background information, interaction matrix methodologies, network methodologies etc, environmental setting- various factors, documentation and selection process, environmental indices and indicators for describing affected environment.

EIA notification by Ministry of Environment and Forest (Govt. of India): Provisions in the EIA notification, Categorization of Industries for seeking environmental clearance from concerned authorities, procedure for environmental clearance, procedure for conducting environmental impact assessment report, Rapid and Comprehensive EIA, general structure of EIA document, Environmental management plan, post environmental monitoring. Case studies in EIA.

Prediction and assessment of impact for air and noise environment: Basic information of air quality, identification of type and quantity of air pollutant, existing air quality and air quality standards, impact prediction and assessment, mitigation. Basic information of noise, existing noise levels and standards, prediction of noise levels and assessment of impact, mitigations.

Prediction and assessment of impact for water and soil environment: Basic information of water quality (Surface water and groundwater), water quality standards, identification of impact, prediction of impact and assessment, mitigations. Background information of soil environment, soil and groundwater standards, prediction and assessment of impact for groundwater and soil, mitigations.

Prediction and assessment of impact on cultural and socioeconomic environment: Basic information on cultural resources, rules and regulations for cultural resources like archaeological, historical structures, Cultural system, prediction and assessment of impact, mitigations. Basic information of socio-economic environment, description of existing socio-economic environment, prediction and assessment of impact, mitigation, resettlement and rehabilitation.

References :
5.   Environmental Impact Assessment, Canter R.L., Mc Graw Hill International Edition,1997.
6.   Environmental Impact Analysis Handbook, John G. Rau and David C. Wooten (Ed), McGraw Hill Book
7.   Environmental Impact Assessment Methodologies by Y Anjaneyulu, and Valli Manikkam, BSP Books PVT Ltd
8.   Environmental Impact Assessment by Anji Reddy, BSP Books PVT Ltd

EEM 1.5 (b) WATERSHED MANAGEMENT

Watershed Management Concept: Introduction, Concept of Watershed Management,   History of Watershed Management and its Relevance to India, Watershed Characteristics; Climatic Characteristics, Physiographic Characteristics, Causes of Watershed Deterioration, Effect of Watershed on the Community, Water Resources Region of India

Principles Of Watershed Management: Integrated Watershed Management Approach (IWMA); Objectives of IWMA, Envisaged Results, Success Criteria, Selection of Watershed Village, Equity Issues for Watershed Policies, Factors Causing the Inequality, Benchmark Survey, Remote Sensing Survey in Watershed Management, Land Capability Classification.

Soil Erosion: Introduction, Soil Erosion, Factors Affecting Soil Erosion, Different Types and Causes of Erosion- Geologic Erosion, Accelerated Erosion, Estimation of Loss of Soil from Erosion, Soil Loss Models, Sediment Models, Bed Load Models, Control of Soil Erosion
Management Of Natural Drainages: Introduction, Check Dam, Structures for Gully Stabilization and Storage of Water, Rivers or Stream Bank Management Measures in Watershed, River Training Works, Methods of River Training Works

Wasteland And Land Drainage Management: Introduction, Causes of Wasteland – Water logging, Salinity, Soil Erosion, Overgrazing, Mining Operation, Industrial Effluent, Brickfields, Inadequate Surface and Subsurface Drainages, Remedial Measures in Wasteland Management, Land Drainage Management- Surface or Overland Drains, Subsurface or Underground Drains, Discharge and Spacing of Tile Drain.

Flood Damage Mitigation Management: Introduction, Mitigation Measures, Structural Mitigation Measures, Non-Structural Mitigation Measures, Flood Plain Zoning, Flood Forecasting.
WATER HARVESTING: Introduction, Techniques of Water Harvesting, Indigenous Water Harvesting Methods in India, Engineering Methods of Water Harvesting.

Watershed Modelling: Introduction, Data of Watershed for Modeling, Application of Watershed Models, Model Calibration and Validation

Text book:
1.   Madan Mohan Das, Mimi Das Saikia, "Watershed Management", PHI Learning Pvt. Ltd
2.   Murty, J.V.S., Watershed Management, New Age Intl., New Delhi 1998.
3.   Vir Singh, R., Watershed Planning and Management, Yash Publishing House, Bikaner,

EEM 1.5 (c) ECOLOGICAL AND ECO SYSTEMS ENGINEERING

Development and evolution of ecosystems – Principles and concepts – Energy flow and material cycling – productivity – Classification of ecotechnology – ecological engineering.

Classification of systems – Structural and functional interactions of environmental systems – Mechanisms of steady-state maintenance in open and closed systems

Classification of ecotechnology - Principles and components of Systems and Modeling-Modeling and ecotechnology – Classification of ecological models – Applications- Ecological economics-Self-organizing design and processes – Multi seeded microcosms.

Self organizing processes - Multiple seeded microcosms- Interface coupling in ecological systems - Concept of energy - Adapting ecological engineering systems to potentially catastrophic events - Agro ecosystems - Determination of sustainable loading of ecosystems.

Ecosanitation – soil infiltration systems–Wetlands and ponds–Source separation systems–Aqua cultural systems – Agro ecosystems – Detritus based treatment for solid wastes –marine systems-Case studies.

References:
1.   Kangas, P.C. and Kangas, P., *Ecological Engineering: Principles and Practice*, Lewis Publishers,
2.   Etnier, C. and Guterstam, B., *Ecological Engineering for Wastewater Treatment*, Lewis Publishers,
3.   Concepts of Ecology by Kormondy, PHI Publications

EEM 1.6 (a) REMOTE SENSING & GIS APPLICATIONS

Introduction : Definition, Principle of Remote Sensing, History of Development of Remote Sensing, Stages in Remote Sensing, Electromagnetic Radiation and the Electromagnetic Spectrum, Interactions with the Atmosphere, Atmospheric Scattering, Atmospheric Absorption, Atmospheric Windows, Refraction, Interaction of EMR with the Earth's Surface, Reflection, Transmission, Spectral Signature.

Platforms & Sensors: Remote Sensing Systems, Remote Sensing from Space, Remote Sensing Sensors, Resolution, Imaging sensors, Optical Infrared (OIR) Imagers, Optical Sensors, Thermal Sensors, Microwave Sensors, Active Microwave Sensors, Data Preprocessing, Remote Sensing in India.
Introduction To Image Interpretation: Basic Principles of Image Interpretation, Elements of Image Interpretation, Techniques of Image Interpretation, Interpretation Keys,

Introduction To Digital Image Processing: Digital Image- Image Rectification And Registration-Geometric Correction, Image Enhancement Techniques (only concepts), Image Classification -

Unsupervised Classification and Supervised Classification. Digital Photogrammetry - Stereo Images from Satellites - Data Merging .

Geographic Information Systems (Gis); Definitions and related technology, GIS Operations, GIS Elements, GIS Concepts and Practice, Map projection and Coordinate system.

Vector Data Model: Introduction, Vector Data Representation, Geometric Objects, Topology.

Vector Data Analysis: Introduction, Buffering, Applications of Buffering, Map Overlay, Feature Type and Map Overlay, Map Overlay Methods, Slivers, Error Propagation in Map , Overlay, Distance Measurement, Map Manipulation,

Raster Data Analysis: Introduction, Analysis Environment, Local Operations, Local Operations with a Single Grid, Local Operations with Multiple Grids, Neighborhood Operations, Zonal Operations.

Terrain Mapping And Analysis: Introduction, Data for Terrain Mapping and Analysis, Surface models-DEM, TIN.

GIS Models And Modeling: Introduction, GIS Modeling, Binary Models, Index Models

Remote Sensing & GIS Application In Water Resources Engineering: GIS approach water resources system – Thematic maps - Rainfall-runoff modelling – Groundwater modeling – Flood inundation mapping and Modelling – Drought monitoring – Site selection for artificial recharge - Reservoir sedimentation.

Text Books :
1.   Fundamentals of Remote Sensing 2nd Ed – George Joseph, University Press, New Delhi.
2.   Introduction to Geographic Information systems – Kang tsung chang, Tata Mc.G.H. publications, New Delhi.
3.   Lillesand, T.M. and Kieffer, Remote sensing and image interpretation, Joh Wiley and Sons, New York, 1987.

Reference Books:
1.   Remote Sensing of the Environment – An earth resource prespective – John R. Jensen, Pearson Education, New Delhi.
2.   Aronoff, S. 1989. Geographic information Systems: A Management Perspective. Ottawa: WDL publications.
3.   Bonham – Carter, G,F. 1994. Geographic Information Systems for Geoscientists: Modeling with GIS. New York: Pergamon Press.
4.   Burrough, P.A and R.A. McDonnell. 1998. Principles of Geographical Information Systems. Oxford: Oxford University Press.
5.   Lo, C.P., and Albert K.W. Young concepts and Technologies of Geographic Information Systems, Prentice hall of India (Pvt) Ltd, New Delhi.

EEM 1.6 (b) ENVIRONMENTAL LEGISLATIONS

Introduction : Indian Constitution and Environmental Protection – National Environmental policies – Precautionary Principle and Polluter Pays Principle – Concept of absolute liability – National and International multilateral environmental agreements and Protocols – Montreal Protocol, Kyoto agreement, Rio declaration etc – Institutional framework (SPCB/CPCB/MOEF) - Supreme Court Judgments in Landmark cases

Water (P & CP) Act, 1974: Power & functions of regulatory agencies - responsibilities of Occupier, Provision relating to prevention and control, Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Water Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

Air (P & CP) Act, 1981: Power & functions of regulatory agencies - responsibilities of Occupier, Provision relating to prevention and control, Scheme of Consent to establish, Consent to operate – Conditions of the consents – Outlet – Legal sampling procedures, State Air Laboratory – Appellate Authority – Penalties for violation of consent conditions etc. Provisions for closure/directions in apprehended pollution situation.

Environment (Protection) Act 1986: Genesis of the Act – delegation of powers – Role of Central Government - EIA Notification – Sitting of Industries – Coastal Zone Regulation - Responsibilities of local bodies mitigation scheme etc., for Municipal Solid Waste Management - Responsibilities of Pollution Control Boards under Hazardous Waste rules and that of occupier, authorization – Biomedical waste rules – responsibilities of generators and role of Pollution Control Boards

Other Acts & Management Systems: Relevant Provisions of Indian Forest Act, Public Liability Insurance Act, CrPC, IPC -Public Interest Litigation - Fundamentals of Environmental Management and ISO 14000 series - principles and elements. The ISO 14001- Environmental management systems standards.

References:
1.   CPCB, "Pollution Control acts, Rules and Notifications issued there under "Pollution Control Series – PCL/2/1992, Central Pollution Control Board, Delhi, 1997.
2.   "Environmental law and policy in India"by Shyam Divan and Armin Roseneranz, Oxford University Press, New Delhi, 2001.
3.   "Environmental law and enforcement", by Greger I. Megregor, Lewis Publishers, London1994.
4.   Constitution of India [Referred articles from part-III, part-IV and part-IV A]
5.   Handbook of environmental management and technology: Gwendolyn Holmes, Ben Ramnarine Singh, Louis Theodore.
6.   The ISO 14000 Handbook: Joseph Cascio.
7.   ISO 14004: Environmental management systems: General guidelines on principles, systems and supporting techniques (ISO 14004:1996 (E)).
8.   ISO 14001: Environmental management systems.

EEM 1.6 (c). OCCUPATIONAL HEALTH, SAFETY AND HYGIENE

Introduction: Need for developing Environment, Health and Safety systems in work places. Regulations and Codes of Practice. Role of trade union safety representatives. International initiatives. Ergonomics and work place.

Occupational Health and Hygiene**:** Definitions. Categories of health hazards. Exposure pathways and human responses to hazardous and toxic substances. Advantages and limitations of environmental monitoring and occupational exposure limits. Hierarchy of control measures for occupational health risks. Role of personal protective equipment and the selection criteria. Effects on humans, control methods and reduction strategies for noise, radiation and excessive stress.

Workplace Safety and Safety Systems: Features of the satisfactory design of work premises HVAC, ventilation. Safe installation and use of electrical supplies. Fire safety and first aid provision. Significance of human factors in the establishment and effectiveness of safe systems. Safe systems of work for manual handling operations. Control methods to eliminate or reduce the risks arising from the use of work equipment. Requirements for the safe use of display screen equipment. Procedures and precautionary measures necessary when handling hazardous substances. Contingency arrangements for events of serious and imminent danger.

Techniques of Environmental Safety: Methods of effective implementation and review of health & safety policies. Functions and techniques of risk assessment, inspections and audits. Investigation of accidents- Principles of quality management systems in health and safety management. Industry specific EHS issues

Education and Training: Relationship between quality manuals, safety policies and written risk assessments. Records and other documentation required by an organisation for health and safety. Requirements for and benefits of the provision of information, instruction, training and supervision. Factors to be considered in the development of effective training programmes. Principles and methods of effective training. Feedback and evaluation mechanism.

References:
1.   Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995
2.   The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.
3.   Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services 2005

EEM 1.7: ENVIRONMENTAL ENGINEERING LABORATORY

1.   Sampling and characterization of water and wastewater by gravimetric, volumetric and colorimetric methods
2.   Settling Column Analysis for type II settling,
3.   Break point chlorination,
4.   Determination of Dosage of lime-soda for removal of hardness
5.   Media preparation and inoculation
6.   Test for plate count
7.   Coliforms – fecal coliforms – E.coli
8.   M.P.N. and M.F. techniques.
9.   Bioassay study
10.   Sampling and analysis of ambient air for SPM, SO2, Oxides of nitrogen
11.   Instrumental methods of analyses for particulates, HC, CO, NOx, SO_2.

References:
1.   Chemistry for Environmental Engineers, by Sawyer, C.N. and McCarty, P.L. and Parkin, G.F. McGraw Hill,
2.   Environmental Chemistry, by De.A.K. New Age International Ltd..
3.   Standard Methods for the Examination of Water and Wastewater, 21th Edition, American Public Health Association, Washington. D.C. 2005.

EEM 1.8. CASE STUDIES

Each student must submit two case studies related to Environmental Studies and face viva-voce examination.

II – SEMESTER

EEM 2.1: ADVANCED WATER AND WASTEWATER TREATMENT

Physical and Chemical Treatment: Screening, Grit removal, Aeration and gas transfer, Application of Membrane Processes, Reverse Osmosis, Micro-filtration, Nano-filtration, Ultrafiltration and Electrodyalisis Chemical precipitation, other solids removal operations, Control of odour, Control of volatile organic compounds.

Theory of Sedimentation – flocculent particle settling – theory of coagulation and flocculation-zeta potential - Filtration - theory of granular media filtration – head loss cleaning of filter media - backwash hydraulics – Theory of chlorination – equilibrium constants.

Principles: Objectives of biological treatment significance - aerobic and anaerobic treatment kinetics of biological growth - factors affecting growth – attached, suspended and Hybrid growth systems. Determination of kinetic coefficients for organics removal – Biodegradability assessment – selection of process – reactors – batch & continuous type

Aerobic Treatment of Wastewater: Design and construction aspects and the relevant parameters of significance of the units: Activated Sludge Process, Trickling Filters, Aerated Lagoons, Rotating Biological Contactors, Sequential Batch Reactors (SBR), Stabilization ponds, Hybrid reactors for the treatment of wastewater :– IFAS, MBBR, MBR, Expanded / fluidized bed bio reactors

Anaerobic Treatment of Waste Water: Sludge handling and treatment -Sludge digestion: theory and principles - Disposal of digested sludge, Anaerobic ponds, UASB reactors and various modifications in UASB process and anaerobic filters. Two stage /phase reactors – biogas generation.

References:
1.   Wastewater Engineering, Treatment and Reuse. Metcalf & Eddy, Inc. Tata McGraw-Hill Publications
2.   Biological Processes Design for wastewaters, Benefield, L.D. and Randall C.W. Prentice-Hall, Inc.
3.   Wastewater treatment for Pollution Control by Arceivala, Tata McGraw Hill Publication
4.   Water and wastewater technology by Hammer and Hammer, PHI Publications

EEM 2.2: AIR POLLUTION AND CONTROL

Introduction: Definition - Sources and classification of Air Pollutants - Photochemical smog - Effects of air pollution on health of Human & Animals, vegetation & materials, air quality, Global effects of air pollution.

Meteorology and Dispersion of air pollutants: Temperature lapse rates and Stability, Wind velocity and turbulence, Wind Rose, plume behaviour, Measurement of meteorological variables. Dispersion of Air pollutants: Theories on modeling of Air pollutants. Gaussian model, Equations for the estimation of pollutant concentrations of emissions. Plume Rise – Equations for estimation. Effective stack height and mixing depths

Sampling and Particulate Pollution Control Methods: Atmospheric sampling and stack sampling methods. Air quality standards.

Types of particulate pollution control methods – Settling chambers, Cyclone separators, Scrubbers, Filters and Electrostatic precipitators, design aspects and principle of these air pollution control units.

Gaseous pollution control methods and automobile pollution: Types of gaseous pollution control methods – absorption, adsorption and combustion processes. Automobile pollution, sources of pollution, composition of auto exhausts, Control methods. Planning for conducting Air pollution survey

Noise Pollution- Definitions – Significance in general - sources, measurement - effects and control measures, noise legislations

Reference Books:
1.   Environmental Engineering, Peavy and Rowe, Mc-Graw Hill Publication.
2.   Air Pollution Control Engineering,. N.D. Nevers, Mc-Graw Hill Publication.
3.   Air Pollution, M. N. Rao and HVN Rao Tata Mc-Graw Hill Publication.
4.   Air pollution and control, KVSG Murali Krishna. Kaushal and Company, Kakinada
5.   An Introduction to Air Pollution by RK Trivedy and PK Goel, BSP Books PVT Ltd
6.   Environmental Pollution Control Engineering by CS Rao, New Age Publications
7.   Air pollution Control Technologies by Anjaneyulu, Allied Publishers

EEM 2.3: SOLID AND HAZARDOUS WASTE MANAGEMENT

Introduction: Definition of solid waste – waste generation, sources and types of solid waste – sampling and characterization – Determination of composition of Municipal Solid Waste – Onsite storage and handling of solid waste.

Collection and Transport of Solid Waste: Type and methods of waste collection systems, analysis of collection system Optimization of collection routes– alternative techniques for collection system. Transfer and Transport: Need for transfer operation, transport means and

methods, transfer station types and design requirements. Separation and Processing and Transformation of Solid Waste- Waste as a Resource Economics, Disposable Materials, Recycling Collection, Processing, Potential for Reuse

Processing and disposal: Unit operations used for separation and processing, Materials Recovery facilities, Source reduction and waste minimization, Metal Separation & Recovery Waste transformation through combustion and composting, anaerobic methods for materials recovery and treatment – Energy recovery – biogas generation and cleaning– Incinerators. Landfills**:** Site selection, design and operation, drainage and leachate collection systems –designated waste landfill remediation.

Hazardous Waste Management: Definition and identification of hazardous wastes-sources and characteristics – hazardous wastes in Municipal Waste – Hazardous waste regulations – minimization of Hazardous Waste-compatibility, handling and storage of hazardous waste-collection and transport, e-waste - sources, collection, treatment and reuse.

Hazardous waste treatment technologies - Design and operation of facilities for physical, chemical and thermal treatment of hazardous waste – Solidification, chemical fixation and encapsulation, incineration. Hazardous waste landfills: Site selection, design and operation – remediation of hazardous waste disposal sites.

References:
1.   Integrated Solid Waste Management, George Techobanoglous McGraw Hill Publication,
2.   Hazardous Waste Management, Charles A. Wentz; McGraw Hill Publication,
3.   Solid and Hazardous Waste Management by MN Rao, Razia Sultana, BSP Books
4.   Municipal Solid Waste Management by P Jayaramireddy, BSP Books PVT Ltd
.

EEM 2.4 : INDUSTRIAL WASTE TREATMENT

Introduction: Sources and types of industrial wastewater – Nature and Origin of Pollutants - Industrial wastewater and environmental impacts – Regulatory requirements for treatment of industrial wastewater – Industrial waste survey – Industrial wastewater monitoring and sampling -generation rates, characterization and variables –Toxicity of industrial effluents

Pollution Prevention & unit operations: Prevention and Control of Industrial Pollution – Benefits and Barriers – Waste management Hierarchy – Source & reduction techniques – Strength & volume Reduction - Material balance - Evaluation of Pollution prevention options - Waste minimization Circles. Equalisation - Neutralisation – Oil separation – Flotation – Precipitation – Heavy metal Removal– Aerobic and anaerobic biological treatment – High Rate reactors - Chemical oxidation – Ozonization – carbon adsorption -Photocatalysis – Wet Air Oxidation – Evaporation – Ion Exchange – Membrane Technologies – Nutrient removal.

Wastewater Reuse And Residual Management: Individual and Common Effluent Treatment Plants – Joint treatment of industrial and domestic wastewater - Zero effluent discharge systems - Quality requirements for Wastewater reuse – Industrial reuse , Present status and issues -

Disposal on water and land – Residuals of industrial wastewater treatment – Quantification and characteristics of Sludge – Management of RO rejects.

Manufacturing process and sources of effluent from the process of industries like fertilizer, pulp and paper, sugar, distillery, tannery, food processing, dairy and Pharmaceuticals, Industrial manufacturing process description, wastewater characteristics, and source reduction options

Manufacturing process and sources of effluent from the process of industries like: Steel, Petroleum Refineries, Textiles, Atomic Energy Plants, Metal finishing and other Mineral Processing Industries. Industrial manufacturing process description, wastewater characteristics, and source reduction options

References:
1.   Industrial Waste Water Pollution Control, W. Wesley Eckenfelder Jr...
2.   Wastewater Treatment for Pollution Control, Arceivala, S.J., McGraw-Hill, 1998.
3.   Industrial waste treatment Handbook, Frank Woodard, Butterworth Heinemann, New Delhi, 2001.
4.   Waste water treatment, M.N.Rao &A.K. Datta
5.   Industrial waste treatment – contemporary practice and vision for the future, Nelson Leonard Nemerow, Elsevier, Singapore, 2007

EEM 2.5 (a) DISASTER MANAGEMENT

Introduction, Disaster Management ,Hazards and Disasters: Earthquake Risk Management, Tsunami Risk Reduction, Flood Risk Management, Cyclone Risk Management, Drought Risk Management, Post-tsunami Hazards along the Indian Coast.

 Risk and Vulnerability: Building Codes and Land Use Planning, Social Vulnerability, Macro-economic Management and Sustainable Development ,Environmental Vulnerability and Disaster Risk Reduction ,Climate Change Risk Reduction, Financial Management of Disaster – related Economic Losses.

Disaster Reduction Technology: Implementation Technology for Disaster Reduction, Disaster Management for Infrastructure, Geospatial Information in Agricultural Drought Assessment and Monitoring, Multimedia Technology in Disaster risk Management Training, Transferable Indigenous Knowledge in Disaster Reduction.

Education and Community: Education in Disaster Risk Reduction, Essential of School Disaster Education, Community Capacity and Disaster Resilience, Community-based   Disaster Recovery, Community-based Disaster Management and Social Capital, Designing Resilience.

Crosscutting Issues: Disaster, Environment and Development, Impact   of   Disasters   on Poverty and Deprivation, Climate Change adaptation and Human Health, Exposure, Health Hazards and Environmental Risk. Hydro-meteorological disasters and Agriculture, Forest Management and Disaster Risk Reduction.

Rural Livelihood and Disaster Risk Reduction, Essentials of Urban Disaster Risk Reduction, Institutional Capacity in Disaster Management, Corporate Sector and Disaster Risk Reduction, Essentials of Pre-disaster Recovery Planning, Experiences of Disaster Risk Reduction .

Books:
4.   Disaster Management ,R.B.Singh, Rawat Publications
5.   Natural Disaster Management ,Jon Ingleton
6.   Disaster Management, Rajib Shaw and RR Krishnamurthy, Universities Press, Hyderabad.
7.   Disaster Management by Pandey, Wiley Publications

EEM 2.5 (b). AGRICULTURAL POLLUTION CONTROL

Environmental issues in agriculture: Types of farming systems, agro meteorology, water and nutrients requirement.

Fertilizers, pesticides, herbicides: types of fertilizers, pesticides and other agrochemicals, soil and water conservation practices. Natural fertilizers, pesticides and herbicides- green practices in agriculture yield improvement

Water logging and salinity**:** causes and effects. Wastewater reuse in agriculture, management and control of agricultural waste, recycling and reuse.

Biotechnology in reduction of CO_2 emission, Bio-scrubbers, Bio-beds, Bio-trickling filters and their applications.

Novel methods of pollution control: Methane production, Root zone treatment, Membrane technology.

Reference Books:
1. Microbial Biotechnology: A. N. Glazer and H. Nikaids .
2. Molecular Biotechnology: Gleek and Pasternack.
3. Biotechnology: A Text Book of Industrial Microbilogy, T. D. Brock,
4. Industrial Microbiology: Presscott and Dunn.
5. Biotechnology: B. D. Singh, Kalyani Publishers.
6. Soil & Ground Water Pollution from Agricultural activities, T.V.Ramachandra, TERI

EEM 2.5 (c). ENVIRONMENTAL BIOTECHNOLOGY

Environmental Biotechnology: Principles and concepts - usefulness to mankind. Degradation of high concentrated toxic pollutants- halogenated, non halogenated, petroleum hydrocarbons, metals - Mechanisms of detoxification – oxidation - dehalogenation - biotransformation of metals - biodegradation of solid wastes.

Biofilm Kinetics: Microbial aggregation-idealized biofilm-Steady state biofilm – soluble microbial products and inert biomass- non steady state biofilms.

Microbial cell/enzyme technology – adapted microorganisms – biological removal of nutrients – algal biotechnology– extra cellular polymers - Biogas technology. Concept of rDNA technology – expression vectors – mutation – construction of microbial strains - radioactive probes - protoplast fusion technology – applications.

Biotechnological remedies for environmental pollution - decontamination of groundwater – Bioremediation: Scope and characteristics of contaminants- contaminant availability for biodegradation- Engineering strategies for bioremediation – evaluation of bioremediation.

Environmental effects and ethics of microbial technology – genetically engineered organisms- Microbial containment-Risk assessment.

Books:
1.   Environmental Biotechnology: Principles and Applications by Rittmann., B.E. and McCarty, P.L ,Tata McGraw-Hill,
2.   Biological degradation of wastes by Martin.A.M, Elsevier Applied Science.
3.   Environmental Biotechnology by Scraqq, Oxford Publications
4.   Environmental Biotechnology by Bhattacharya and Banerjee, Oxford Publications

EEM 2.6 (a). ENERGY, ENVIRONMENT AND SUSTAINABILITY

Introduction: Sustainable Development – Indicators of Sustainability – Sustainability Strategies- Barriers to Sustainability – Industrial activity and Environment – Industrialization and sustainable development. Cleaner Production (CP) in Achieving Sustainability –Principles Cleaner Production, Definition, Importance Historical evolution, Benefits, Promotion, Barriers, Role of Industry, Government and Institutions, Industrial Ecology, clean development mechanism, reuse, recovery, recycle, raw material substitution.

Cleaner Production Project Development and Implementation: Overview of Cleaner Production (CP) Assessment Steps and Skills, Process Flow Diagram, Material Balance, CP Option Generation – Technical and Environmental Feasibility analysis – Economic valuation of alternatives - Total Cost Analysis – CP Financing – Preparing a Program Plan – Measuring Progress – Pollution Prevention and Cleaner Production Awareness Plan – Waste audit – Environmental Statement, carbon credit, carbon sequestration, carbon trading, Life Cycle Assessment **-** Elements of LCA – Life Cycle Costing – Eco Labelling

Green Technology - Definition of green building, benefits and challenges, public policies and market-driven initiatives, effective green specifications. Overview of the Building Energy System Design Process. Assessing human functional and physiological smart growth- needs, local climate and free energy resources. Design scenarios- Day lighting , Electric Lighting.

Availability and need of conventional energy resources, major environmental problems related to the conventional energy resources, future possibilities of energy need and availability. Non-conventional energy sources: Solar Energy- process of photovoltaic energy conversion, solar energy conversion technologies and devices, their principles, working and application.

Biomass energy: Concept of biomass energy utilization, types of biomass energy, conversion processes, Wind Energy, energy conversion technologies, their principles, equipment and suitability in context of India.

References:
1. 'Pollution Prevention: Fundamentals and Practice', Paul L Bishop (2000) McGraw Hill International.
2. 'Pollution Prevention and Abatement Handbook – Towards Cleaner Production', World Bank Group (1998) World Bank and UNEP, Washington D.C.
3. 'Cleaner Production Audit', Environmental System Reviews, No.38, Prasad Modak, C.Visvanathan and Mandar Parasnis (1995) Asian Institute of Technology, Bangkok
4. Handbook of organic waste conversion, . Bewik M.W.M.
5. Industrial Ecology and Sustainable Engineering by Graedel Allenby, PHI Publications

EEM 2.6 (b). SURFACE AND GROUND WATER HYDRAULICS

Land Processes – Subsurface and Channel Processes- Precipitation – Rain gauge network, Abstractions, Infiltration, Evaporation, Transpiration, Process and models

Unit Hydrograph & S curve hydrograph, Dimensionless unit hydrograph, GUIH, Watershed Model and Conceptual Models.

Occurrence and Movement of Ground water, Properties of aquifer, Groundwater flow equations, Dupuit Forchheimer assumptions, Well hydraulics, Partial penetration of wells, Interference of wells, Collector wells and Infiltration galleries.

Pumping tests, Analysis for unconfined and non leaky and leaky confined aquifer and water table aquifer, Locating hydro geologic boundaries, Well design criteria.

Natural and Artificial Recharge of Ground water- Salt water intrusion, Application of Finite Difference in ground water.

References:
1.   Ven Te Chow, "Applied Hydrology", Mc GrawHill Science Publishers
2.   Singh, Vijay ., "Elementary Hydrology", Prentice Hall
3.   Raghunath. "Ground Water", Mc Graw Hill.
4.   Bear, J., Hydraulics of Ground water, Mc Graw Hill.
5.   Surface water quality modeling by Chapra, McGraw Hill Publication

EEM 2.6 (c). PLUMBING SERVICES AND MAINTENANCE

Introduction to Plumbing systems: Defintion-classification of plumbing systems- plumbing appliance- plumbing appurtenance- plumbing fixture- Single-Multi Family buildings, Restaurants, Handicap Fixtures: Toilets, Sinks and Lavatories, Sink and Lavatory Faucets, Bathing Units, Drinking Units. Standard Fixture Installation Regulations. Sewers- building sewers- faucet- self-closing faucet- Interceptor. Water safety plans in operation and managements of water systems- The role of plumber in risk assessment and risk management-codes of practice for plumbing.

Water Supply And Distribution: The Main Water Pipe: Supplies, Pressure-Reducing Valves , Water Hammer, Tanks, Pressurized Water Tanks. Pipe Support: Water Conservation, Antiscale Precautions, Valve Regulations, Cutoffs. Backflow Prevention. Hot-Water Installations-Water Heaters. Water Supplies –Fixture. Minimum Pipe Size.

Sanitary Drainage Systems: Sizing Building Drains and Sewers -Horizontal Branches -Stack Sizing –Installation: Pipe Joints, Fittings -Offsets in Horizontal Piping- Horizontal to Vertical Changes in Direction -Vertical to Horizontal Changes in Direction

Vents, Traps, clean-outs and Interceptors: Sewer Gas -Trap Seals, Plumbing Vents -Individual Vents -Relief Vents -Circuit Vents -Developed Length -Branch Vents -Vent Stacks -Stack Vents -Common Vents -Island Vents -Wet Vents -Crown Vents -Vent-Installation Requirements. Clean-outs --Types of Clean-outs –Traps: P-Traps -S-Traps -House Traps -Crown-Vented Traps -Other Traps -Trap Sizes -Tailpiece Length -Standpipe Height -Proper Trap Installation -Grease Traps -Backwater Valves.

Storm Drainage and Special Piping And Storage Systems: Sizing -Sizing Rain Leaders and Gutters -Roof Drains -More Sizing Information, Sump Pumps -Variations. Special Piping And Storage Systems: General Requirements -Sterilizers -Aspirators -Medical Gases -Oxygen Systems.

References:

EEM 2.7 : ENVIRONMENTAL PROCESS DESIGN AND DRAWING

Review of the Principles of design and drawing of water supply and treatment units from source to distribution system.

Review of Principles of design and drawing of wastewater treatment units.

Detailed design and drawings of various types of intake structures, conduits, pipes, ground level reservoirs and elevated service reservoirs.

Preparation of drawings for various house plumbing fixtures.

Design and drawings of various types of distribution systems and various methods of analysis of distribution networks

Text Books :
1.   Public Health Engineering By Duggal.
2.   Water Supply and Sanitary Engineering By Birdi.
3.   Water Supply and Sanitary Engineering By Hussain.

EEM 2.8 : SEMINAR

Each student has to select a topic and collect about 10 papers with at least 5 journal papers and prepare a report and give a seminar at the end of the semester

Department Of Civil Engineering
M TECH. (GEOTECHNICAL ENGINEERING)
Scheme of Instruction and Examination
(with effect from 2015-16 academic year)

I – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
GT 1.1	Advanced Soil Mechanics	4	--	4	3	70	30	100	4
GT 1.2	Advanced Foundation Engineering	4	--	4	3	70	30	100	4
GT 1.3	Geosynthetics and Reinforced Soil Structures	4	--	4	3	70	30	100	4
GT 1.4	Earthquake Geotechnical Engineering	4	--	4	3	70	30	100	4
GT 1.5	a) Subsoil Exploration b) Geotechnics of Industrial Wastes c)Soil Science	4	--	4	3	70	30	100	4
GT 1.6	a) Rock Mechanics b)Pavement Analysis and Design c)R S & GIS Applications	4	--	4	3	70	30	100	4
GT 1.7	Soil and Rock Mechanics Lab.	--	3	3	Viva	50	50	100	2
GT 1.8	Geosynthetics Lab.		3	3	Viva	50	50	100	2
Total		**24**	**6**	**30**		**520**	**280**	**800**	**28**

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
GT 2.1	Soil Dynamics and Machine Foundations	4	--	4	3	70	30	100	4
GT 2.2	Ground Improvement Techniques	4	--	4	3	70	30	100	4
GT 2.3	Earth and Earth Retaining Structures	4	--	4	3	70	30	100	4
GT 2.4	Geoenvironmental Engineering	4	--	4	3	70	30	100	4
GT 2.5	a)Problematic Soils b)Reliability Analysis c)Finite Element Methods of Analysis	4	--	4	3	70	30	100	4
GT 2.6	a) Marine Substructures b)Forensic Geotechnical Engineering c)Geotechnics of Underground Structures	4	--	4	3	70	30	100	4
GT 2.7	Design Project	--	3	3	Viva	50	50	100	2
GT 2.8	Seminar		3	3	Viva	50	50	100	2
Total		**24**	**6**	**30**		**520**	**280**	**800**	**28**

III and IV SEMESTERS

Code No	Course title	Scheme of Examination	Total Marks	Credits
GT3.1	Dissertation (Preliminary)	Viva-voce	**100**	**10**
GT4.1	Dissertation (Final)	Defence and Viva-voce	**100**	**14**

I – SEMESTER

GT 1.1 ADVANCED SOIL MECHANICS

Elements of elasticity: State of stress at a point, stress function, equilibrium equation, compatibility equation, boundary conditions, Hooke's lay, two dimensional problems, principle stress and strain, octahedral stresses, stress invariants, Mohr's representation.

Elements of plasticity: Ideal plastic substance, strain hardening, yield criteria – Tresca, Hises and Mohr, Coulomb theories of failure and failure envelops in cohesionless and cohesive soils.

Rheological models–Hookean, Newtonian, rigid plastic, Elasto–plastic, Kelvin–Voigt and Maxwell models.

Soil strength: Effective stress law for saturated and partially saturated soil, pore pressure measurements in partially saturated soils, effective stress concept, effect of intermediate principal stress, effect of rate of stress, stress dilatancy theory, plane strain and stress path Hvorslov shear strength parameters

Clay Minerals: Classification, Structure, properties; Identification of clay minerals - X ray Diffraction, Electron Microscope and Differential Thermal Analysis.

Reference books:
1.   Soil Behaviour by James K Mitchell, John Wiley & Sons Inc
2.   Foundation of theoretical soil mechanics by M. E. Harr, Mc Graw Hill book co.
3.   Selected topics in soil mechanics by I. K. Lee, Butler Warth
4.   Rheological aspect of Soil Behaviour by Sukhje, *Thomas* Telford Publishing

GT 1.2 ADVANCED FOUNDATION ENGINEERING

Introduction: Principles of Design of Foundations, Types of shear failures in foundation soils, Types of foundations, Design Loads, Basic Concepts of safe and allowable bearing capacity. Shallow Foundations

Bearing Capacity Analysis: Bearing capacity theories – Terzaghi, Meyerhof, Skempton, Hansen, Vesic and IS Methods, Bearing capacity evaluation from Standard Penetration test and Plate load test.

Settlement Analysis: Uniform and Differential Settlements, Elastic and Consolidation Settlements, Settlement analysis in cohesionless soils by Schemartmann and Hartman method,

Penetration tests; Permissible settlements as per IS 1904-1978, causes of settlement, settlement Control.

Proportioning of footings: Isolated column footings, Strip, combined Footings and Strap Footing.

Raft Foundations: Bearing capacity of raft foundation, floating raft, Types of rafts, Beam on Elastic foundation and Conventional methods of Design, determination of modulus of subgrade reaction.

Deep Foundations: Pile Foundations, Types, load capacity- dynamic formulae, static formula; pile load tests- Vertical load test, lateral load test, Cyclic load test; settlement of piles and pile groups, negative skin friction on single pile and pile groups; laterally loaded piles - Broom's Analysis, IS Code method; Under reamed piles – Load capacity, design and construction.

Well Foundations: Types, Bearing Capacity of well foundations, Construction of pneumatic caissons, Tilts and Shifts: precautions, Remedial measures; Lateral stability analysis by Terzaghi's Method, Design aspects of Components of well foundation.

Foundations in Expansive Solis : Introduction, Identification of expansive soils, Swell potential and swelling pressure, Active depth, Foundation Problems, Foundation practices in expansive soils, Soil Replacement and 'CNS' concepts.

Foundations of Transmission Line Towers: Introduction, Necessary information, Forces on tower foundations, General design criteria, Choice and type of foundation, Design procedure.

Reference Books:
1.   Foundation Analysis and Design by J.E. Bowles, Mc Graw Hill Publishing Co.
2.   Foundation Design by W.C. Teng, John Wiley, New York.
3.   Analysis and Design of Substructures by Swami Saran, Oxford &IBH Publishing Co.
4.   Foundation Engineering by P.C. Vargheese, Prentice Hall of India
5.   Basic and Applied Soil Mechanics by Gopal Ranjan and A.S.R. Rao, New Age International Publications

GT 1.3 GEOSYNTHETICS AND REINFORCED SOIL STRUCTURES

Reinforced Earth: Concept, Effects of Reinforcement on soils – Equal Confining and Psuedo Cohesion Concepts, Materials, Friction Coefficient – Definition, Laboratory determination, Factors affecting fiction coefficient; Application of Reinforced Earth

Geosynthetics: Types, Functions, Tests on Geosynthetics, Durability aspects, Applications

Reinforced Earth Retaining Walls: Introduction, Stability Mechanisms, Design of Reinforced Earth Retaining Wall, Advantages over conventional Retaining Walls

Reinforced Embankments: Introduction, Design of Reinforced Embankment, Foundation mattress below the embankment, Design of Reinforced Mattress

Reinforced Soil Beds: Introduction, Factors affecting the Behaviour of Reinforced Soil Beds, Analysis and Design

Reinforced Pavements: Benefits of placing reinforcement in flexible pavement layers, design of reinforced pavements by Giroud and Noiray approach and modified CBR Method.

References
1.   An Introduction to Soil Reinforcement and Geosynthetics" By G.L. Siva Kumar Babu, University Press
2.   Designing with Geosynthetics by Robert M Koerner,
3.   Advances in Geosynthetics by G. Venkatapparao, Sai Master Geoenvironmental Services Pvt. Ltd. Publications

GT 1.4 EARTHQUAKE GEOTECHNICAL ENGINEERING

Seismology and Earth Quakes: Introduction, Seismic Hazards, seismic waves, internal structure of earth, Continental Drift and plate tectonics, faults, elastic rebound theory, geometric notations, location of earthquakes, size of earthquakes.

Strong Ground Motion: Strong ground motion measurement, Ground motion parameters, Estimation of ground motion parameters.

Seismic Hazard Analysis: Identification and evaluation of earthquake sources, Deterministic Seismic Hazard Analysis, Probabilistic seismic Hazard analysis.

Wave Propagation: Waves in Rods, one dimensional wave equation, Effect of end condition on wave propagation, Mode vibrations of rods of finite length, Wave propagation through elastic infinite medium, Waves in Semi infinite elastic medium.

Dynamic Soil Properties: Measurement of Dynamic Soil Properties using field and laboratory tests (overview), Strength and Stress-strain behavior of cyclically loaded soils.

Ground Response Analysis: One dimensional ground response analysis – Linear and Non-linear approaches.

Local Site Effects: Effect of local site conditions on ground motion, Design parameters, Development of design parameters.

Liquefaction: Flow liquefaction, cyclic mobility, liquefaction hazards, liquefaction susceptibility, Initiation of liquefaction, Effects of liquefaction, liquefaction Control measures

Reference Books:
1.   Geotechnical Earthquake Engineering by Steven L. Kramer, Prentice Hall
2.   Geotechnical Earthquake Engineering Handbook by Robert W. Day, McGraw-Hill Publishing Co

GT 1.5 a) SUBSOIL EXPLORATION

Objectives of Soil Exploration, Methods of Soil Exploration, Depth and Extent of Soil Exploration in Different Civil Engineering Projects

Problems and phases of foundation investigations. Geophysical, sounding, drilling and accessible explorations. Sample requirements, sampling methods and equipment. Handling, preservation and transportation of samples.

Sample preparation, laboratory tests – Triaxial (UU/CU), Consolidation, Swelling pressure. Analysis of results and interpretation, importance of in-situ testing. Performing various in situ tests – File Vane Shear Test, Plate load test, Pile load test, SPT, SCPT, DCPT. Precautions and interpretation. Site evaluation and reporting.

Exploration in Rock and Marine Soil Exploration

Reference books:
1.   Head, K. H., Manual of soil laboratory testing, volume 1 to 3, 1981
2.   Compendium of Indian standards on soil engineering parts I and II, 1987 – 1988

GT 1.5 b) GEOTECHNICS OF INDUSTRIAL WASTES

Wastes from Thermal Power Plants: Fly ash, bottom ash and Pond Ash, availability, Properties, classification, scope for use in civil engineering projects, Present applications.

Agriculture Waste: Rice Husk Ash, Physical, Chemical and Engineering Properties, Potential uses based on its properties.

Wastes from Steel Plants: Blast Furnace Slag, Granulated Blast Furnace Slag and Ground Granulated Blast Furnace Slag, Material properties, potential applications.

Quarry Dust: Production, Properties, comparison with sand, potential uses.

Potential for use of Industrial wastes in stabilization of soils.

Underground Pollution Risk of using Industrial wastes as construction materials and Mitigation. Evaluation methods for studying leaching effect of industrial wastes on underground.

References:
1.   Sridharan and K. Prakash (2009), "Geotechnical Engineering Characterization of Coal Ashes", CBS Publishers
2.   Ground Improvement Techniques by P. Purushothama Raj, Lakshmi Publications, New Delhi.

GT 1.5 c) SOIL SCIENCE

Origin, Formation, classification, structure and properties of clay minerals, identification of Clay minerals- X ray Diffraction, Electron Microscope and Differential Thermal Analysis.

Clay Water Systems – Adsorbed water, Capillary water, Free water, soil suction, bonding forces – Primary and secondary bonds, Crystalline state, ion Exchange, dehydration and rehydration, shrinkage and swelling behavior, sensitivity and thixotrophy, electro-osmosis applications. Chemical composition analysis, p^H analysis, mineralogy of sand and silt, inter particle forces in soils.

Consistency Evaluation parameters of Clays and Sands, Concepts of Effective Stress and Intergranular Stress
Soil Water, Effect of Capillarity on Effective stress, Methods of dewatering and pressure relief, well point systems, deep well drainage, vacuum dewatering, Electrokinetic Dewatering.

Reference Books:
1.   Clay Mineralogy by Ralph,E.Grim, Mc Graw Hill Book Co.
2.   Soil Mechanics for road engineers by H.M.S.O
3.   Soil Behaviour by Mitchell
4.   Soil Behaviour by Young Winterkorn

GT 1.6 a) ROCK MECHANICS

Introduction : Geological formation of rocks, Structural Geology, classification of rocks, Defects in rock, Physical, mechanical properties of rocks, Exploration techniques – RQD and RMR, Laboratory tests for shear strength, tensile strength, flexural strength, elastic constants, Field tests – test for deformability, shear tests and strength tests

Engineering classification of Rock mass, Stress-strain behaviour, Failure criteria for rock masses - Yield criteria for failure theories: maximum stress theories, maximum elastic strain theories etc, and Griffith's theory of fracture initiation, stresses around open flaw and equation defining fracture

Tunnelling in rocks - different phases and methods of tunnelling, Instrumentation in tunnels, Rock freezing, Rock fall, Improvement techniques for rock – Grouting, Rock bolting

Rock reinforcement - Mechanism, types of reinforcement, steps involved in installation, Foundations on rock, Rock blasting- explosives, Selection criteria for explosives, steps involved in blasting

References:
1.	Verma, B. P., "Rock Mechanics for Engineers" Khanna Publishers
2.	.Singh, B. and Goel, R. K. "Rock Mass Classification Systems – A Practical Approach in Civil Engineering "Elsevier Publisher.
3.	Brown, E.T., "Rock Characterisation, Testing and Monitoring", Pergamon Press, London, U.K
4.	Rock mechanics on the design of structures in rock by Oberti and Duvalk, W. L. John Wiley.

GT 1.6 b) PAVEMENT ANALYSIS AND DESIGN

Pavement types, stress distribution pavements - theoretical and actual Sub grade conditions and traffic loading. Design principle and methods for flexible and rigid pavements.

Design of heavy duty pavements. Concrete block pavements.

Evaluation of pavement condition, pavement instrumentation: Types of pavement distresses, their origins and remedy.

Roughness and skid resistance. Environmental effects and influences.

Pavement maintenance, overlays. Pavement management systems.

References:
1.	Pavement Analysis and Design, second edition, by Yang H. Huang, Prentice Hall publishers.
2.	Shell Pavement Design Manual - asphalt pavements and overlays for road traffic, by Nilanjan Sarkar, Ooms Avenhorn Holding India Pvt.Ltd;
3.	Highway engineering by Khanna & Justo .

GT1.6 c) REMOTE SENSING AND GIS APPLICATIONS

Introduction; Definition, Principle Of Remote Sensing, History Of Development Of Remote Sensing, Stages In Remote Sensing, Electromagnetic Radiation And The Electromagnetic Spectrum, Interactions With The Atmosphere, Atmospheric Scattering, Atmospheric Absorption, Atmospheric Windows, Refraction, Interaction Of Emr With The Earth's Surface, Reflection, Transmission, Spectral Signature.

Platforms & Sensors: Remote Sensing Systems, Remote Sensing From Space, Remote Sensing Sensors, Resolution, Imaging Sensors, Optical Infrared (Oir) Imagers, Optical Sensors, Thermal Sensors, Microwave Sensors, Active Microwave Sensors, Data Preprocessing, Remote Sensing In India.

Introduction To Image Interpretation; Basic Principles Of Image Interpretation, Elements Of Image Interpretation, Techniques Of Image Interpretation, Interpretation Keys, Introduction To Digital Image Processing: Digital Image- Image Rectification And Registration- Geometric Correction, Image Enhancement Techniques (Only Concepts), Image Classification - Unsupervised Classification And Supervised Classification. Digital Photogrammetry - Stereo Images From Satellites - Data Merging .

Geographic Information Systems (Gis); Definitions And Related Technology, Gis Operations, Gis Elements, Gis Concepts And Practice, Map Projection And Coordinate System.

Vector Data Model: Introduction, Vector Data Representation, Geometric Objects, Topology. Vector Data Analysis: Introduction, Buffering, Applications Of Buffering, Map Overlay, Feature Type And Map Overlay, Map Overlay Methods, Slivers, Error Propagation In Map , Overlay, Distance Measurement, Map Manipulation,

Raster Data Analysis: Introduction, Analysis Environment, Local Operations, Local Operations With A Single Grid, Local Operations With Multiple Grids, Neighborhood Operations, Zonal Operations.

Terrain Mapping And Analysis: Introduction, Data For Terrain Mapping And Analysis, Surface Models-Dem, Tin.
GIS Models And Modeling: Introduction, GIS Modeling, Binary Models, Index Models

Remote Sensing & GIS Application In Civil Engineering – Some Case Studies From Literature.

Text Books :
1.   Fundamentals Of Remote Sensing 2nd Ed – George Joseph, University Press, New Delhi.
2.   Introduction To Geographic Information Systems – Kang Tsung Chang, Tata Mc.G.H. Publications
3. Lillesand, T.M. And Kieffer, Remote Sensing And Image Interpretation, John Wiley And Sons, New York,

Reference Books:
1.   Remote Sensing Of The Environment – An Earth Resource Prespective – John R. Jensen, Pearson Education,
2.   Aronoff, S. 1989. Geographic Information Systems: A Management Perspective. Ottawa: WDL Publications.
3.   Bonham – Carter, G,F. 1994. Geographic Information Systems For Geoscientists: Modeling With GIS. New York: Pergamon Press.
4.   Burrough, P.A And R.A. Mcdonnell. 1998. Principles Of Geographical Information Systems. Oxford: Oxford University Press.
5.   Lo, C.P., And Albert K.W. Young Concepts And Technologies Of Geographic Information Systems, Prentice Hall Of India (Pvt) Ltd, New Delhi.
6.   John R Jensen : Introductory Digital Image Processing , Prentice Hall, New Jersey.

GT 1.7 SOIL AND ROCK ENGINEERING LAB

Experiments on Soil
1.   Index and Engineering Properties Of soils
2.   Quick Determination of Water content – Rapid Moisture Meter, Proctor's Needle.
3.   Determination of Compression Index, Coefficient of consolidation of clays
4.   Determination of Swell Parameters – Differential Free Swell, Swell Pressure Tests.
5.   Determination of Shear Parameters – Tri-axial Test, Direct Shear Test, Vane Shear test, Unconfined Compression Test.
6.   Determination of Relative Density of granular soils.

Experiments on Rock
1.   Determination of Specific Gravity.
2.   Determination of Unconfined Compression Strength.
3.   Determination of Porosity.
4.   Determination of Water absorption.
5.   Determination of point load Index of Rocks.

Demonstration Tests
1.   Plate Load Test.
2.   Pile Load Test.
3.   Standard Penetration Test.

GT 1.8 GEOSYNTHETICS LAB

1.   Determination of physical properties of Geotextiles, Geogrids and Geomembranes
2.   Determination of Grab and wide width tensile strengths of geotextiles
3.   Determination of Tensile strength of Geogrids and Geomembranes
4.   Determination of Interfacial frictional characteristics of Geotexiles with Fill material
5.   Determination of in plane and cross plane permeability of geotextiles
6.   Determination of Puncture Resistance of geotextiles
7.   Determination of A.O.S of geotextiles
8.   Evaluation of long term flow ability of geotextiles by Gradient ratio test
9.   Cone Drop Test on geotextiles

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II – SEMESTER

GT 2.1 SOIL DYNAMICS AND MACHINE FOUNDATIONS

Theory of Vibration: Free and forced vibrations with and without damping for single mass system with single degree freedom, Logarithmic Decrement and Damping Ratio, Principles of Design of Vibration measuring Devices, Transmissibility of force, vibrations of Two degree freedom system, vibrations of Systems under transient loads.

Natural frequency of foundation soil system- Barkan's Method, Pressure Bulb Concept, Pauw's Analogy, Tschebetorioff's concept of reduced natural Frequency

Dynamic Soil Properties: Tests for determination of dynamic soil properties - Cyclic Plate load test, Block vibration test, Up Hole, down Hole and Cross Hole wave Propagation tests, Hammer Test, Resonant Column Test, Seismic Reflection and Refraction tests.

Design of Machine Foundation: Types of Machine Foundations, design criteria, Degrees of Freedom of Block foundation, Analysis of Block foundations under sliding, rocking, yawing and Coupled motions, Design Aspects and Construction details of foundations for reciprocating and Impact, vibration isolation: active and passive isolation, vibration isolation materials.

References:
1.   Soil Dynamics by Shamsher Prakash, Shamsher Prakash Foundation
2.   Hand Book of Machine Foundations by P. Srinivasulu and C.V. Vaidyanathan, Tata Mc Graw Hill
3.   Dynamics of Bases and Foundation by Barken, Mc Graw Hill Book Co.
4.   Vibration of soil and Foundation by Richart F.E., Hall J.A., Woodes R.E., Prentice Hall

GT 2.2 GROUND IMPROVEMENT TECHNIQUES

Compaction: Theory of compaction, Shallow Surface Compaction - Equipment, Placement water content, factors affecting shallow compaction; Deep compaction: Methods - Vibrofloatation, Terra probe method, Pounding, Blasting, Compaction piles; Compaction Control.

Vertical Drains: Sand drains, Sand wicks, Rope drains, Design of vertical drains, Stone columns, application of the techniques to Marine clays.

Stabilization: Introduction, objectives, Methods of stabilization – Mechanical, Cement, Lime, Bituminous, Calcium chloride; construction methods, factors affecting stabilization of soils; Deep Mixing methods – Soil lime Columns and Cement Lime Columns, applications

Dewatering: Definition, necessity, Methods of dewatering – Interceptor ditch, Single, Multistage and Vacuum well points, Horizontal wells, Electro-osmosis. Permanent drainage by Foundation drains and Blanket drains.

Grouting: Definition, Objectives of grouting, Grouts and their properties, Categories of Grouting, Grouting methods: Asending, Descending and Stage Grouting in Soils, Hydrofracture, Grouting Equipment, Post grouting tests.

In-situ Reinforcement: Ground Anchors, Tiebacks and Soil Nailing, Micropiles.
Reference Books:
1.   Engineering Principles of Ground Modification by Monfred R Hausmann, Mc Graw Hill Publishing Co.
2.   Ground Improvement Techniques by P. Purushothama Raj, Laksmi Publications, New Delhi
3.   Engineering Principles of Ground modification by Manfred R Hausmann, BSP Books PVT Ltd

GT 2.3 EARTH AND EARTH RETAINING STRUCTURES

Earth Pressure: Basic concepts, Rankine and Coulomb earth pressure theories, Determination of active and passive pressures: Culmann's Graphical method, logarithmic spiral methods, friction circle method. Consideration of surcharge, seepage, earth quack, wave effect, stratification, type of backfill, wall friction and adhesion.

Retaining structures: Uses, types, stability and design principles of retaining walls, backfill drainage, settlement and tilting. Sheet Pile Walls: Types, Design of cantilever sheet pile walls in granular and Cohesive soils; Design of anchored sheet pile walls by free and fixed earth support methods, Rowe's theory of moment Reduction, Design of anchors. Braced excavations: Types of sheeting and Bracing systems, lateral earth pressure on sheeting in sand and clay, Design components of braced cuts. Cellular cofferdams: Types – Diaphragm and Circular type, Design by TVA method. Stability of cellular cofferdams, cellular cofferdams in rocks and soils.

Earth and Rock fill dams: Earth dams : Selection of Site, types of earthen dams, design criteria, stability analysis: upstream and down stream for steady seepage, rapid draw down, end of construction; Seepage, Uplift Control, filters and drains, Construction techniques, Slope protection, Failure of earth dams: Hydraulic, Seepage and Structural; Instrumentation and performance observations in earth dams.

Rock Fill Dams: Types, Design parameters, Advantages over other types of dams
Reference books:
1.   Foundation design by W. C. Teng, Prentice Hall
2.   Terzaghi. K. theoretical soil mechanics, John Willey 1965

3.   Terzaghi. K. and Peck R. B. Soil mechanics in engineering and practice 2nd edition, John Wiley 1968.
4.   Bowles. J. W. analysis and design of foundations, McGraw Hill, 4th edition 1955.
5.   Embankment dams by Bharat Shing and S. D. Sharma
6.   Earth and rock fill dams by Shearard, John willey
7.   Design of small dams by U. S. B. R.
8.   Earth manual by U. S. B. R.

GT 2.4 GEOENVIRONMENTAL ENGINEERING

Wastes: source, production and classification of wastes, soil pollution processes, waste characterization.

Waste disposal facilities: Landfills and impoundments, Slurry walls, Types of landfills, Landfill planning and design; Barrier systems – Basic concepts, Design and construction; Stability, compatibility and performance contaminant transformation and transport in subsurface, Monitoring surface contamination, Stabilization and modification of wastes. Reuse of waste materials, contaminated site remediation, Case studies in waste handling.

Soil erosion and conservation: Causes of soil erosions, Factors contributing to erosion – climatic factors, Topographical factors, Vegetation factors. Erosion control – Cropping systems, Gullies, Check dams, Contouring, Wind striping, Ridging, Bank protection, Erosion control with vegetation mats and Silt fences.

Reference books:
1.   Daniel, D. E. Geotechnical practice for waste disposal, Chapman and Hall, London 1993
2.   Rowe, R. K., Quigley, R. M. and Booker, Clay barrier systems for waste disposal facilities, J.R., E & FN Spon, London, 1995
3.   Reddi, L. N., and Inyang, H. F. Geoenvironmental Engineering – principles and applications, Marcel Dekker, 2000
4.   Bagchi, A. Design, construction and monitoring of landfills, John Wiley & Sons, New York 1994
5.   Sharma, H. D. and Lewis, S. P., Waste containment systems, Waste stabilization and landfills: Design and evaluation John Wiley & Sons, New York 1994

GT 2.5 a) PROBLEMATIC SOILS

Expansive Soils: Geology, engineering properties, swelling, swelling pressure, strength and compressibility, permeability stabilization methods, foundation types.

Soft Clays: Geology of soft marine clays, mineralogy, physical properties, shear strength and compressibility, foundation types.

Organic and Peaty Soils, Collapsible soils: Geotechnical properties, foundation types

Liquefiable Soils: Identification, Factors affecting Liquefaction, Methods for improving resistance of soils to Liquefaction

Filled up Soils: Characterization, Methods for Strengthening Filled up material for supporting structures, Foundation practices in Filled up areas.

Soil Stabilization: Principles of soil stabilization; Role of admixtures; Purpose based classification of soils; Methods of stabilization – Lime, cement, bitumen and special chemicals – Mechanisms, uses and limitation; use of fly ash and other waste materials

Reference books:
1.   Tropical soils in engineering practice by S. A. Ola, Balkema publications, Holland
2.   Soil stabilization principles and practice by Ingles, O. G. and Metcalf, J. B., Butterworth,1972

GT 2.5 b) RELIABILITY ANALYSIS

Concepts of Structural Safety: General, Design methods.

Basic Statistics: Introduction, Data reduction, Histograms, Sample correlation.

Probability Theory: Introduction, Random events, Random variables, Functions of random variables, Moments and expectation, Common probability distribution, Extremal distribution.

Resistance Distributions and Parameters: Introduction, Statistics of properties of concrete, Statistics of properties of steel, Statistics of strength of bricks and mortar, Dimensional variations, Characterization of variables, Allowable stresses based on specified reliability.

Probabilistic Analysis of Loads: Gravity loads, Wind load.

Basic Structural Reliability: Introduction, Computation of structural reliability. Monte Carlo Study of Structural Safety: General, Monte Carlo method, Applications.

Level 2 Reliability Methods: Introduction, Basic variables and failure surface, First-order second-moment methods (FOSM).

Reliability Based Design: Introduction, Determination of partial safety factors, Safety checking formats, Development of reliability based design criteria, Optimal safety factors, Summary of results of study for Indian standard – RCC design. Reliability of Structural Systems: Preliminary concepts as applied to simple structures.

References:
1.   "Structural Reliability Analysis and Design" by Ranganatham, R.
2.   "Structural Reliability" by Melchers, R.E.

GT 2.5 c) FINITE ELEMENT METHODS OF ANALYSIS

Introduction: A brief history of F.E.M. Need of the method, Review of basic principles of solid mechanics- Equations of equilibrium, Boundary conditions, Compatibility, Strain displacement relations, Constitutive relationship in matrix form, plane stress & plane strain and axisymmetric bodies of revolution with axi-symmetric loading, Energy principles - Raleigh - Ritz method of functional approximation.

Theory relating to the formulation of the finite element method, Coordinate system (local and global), generalized coordinates, Concept of the element, Various element shapes, Discretisation of a structure, Mesh refinement Vs. Higher order element, Interconnections at nodes of displacement models, inter element compatibility, -shape functions.

Basic component – One dimensional FEM single bar element, Beam element : Derivation of stiffness matrix, Assembly of stiffness, Matrix boundary conditions, shape functions for 1 D elements, Initial strain and temperature effects, and trusses under axial forces.

Two dimensional FEM**:** Different types of elements for plane stress and plane strain analysis – Displacement models Generation of element stiffness and nodal load matrices –static condensation.

Isoperimetric representation and its formulation for 2d analysis. Formulation of 4-noded and 8-noded isoparametric quadrilateral elements – Lagrangian elements-serendipity elements.

References :
1.   Introduction to Finite element Method by Tirupathi chandra Patla and Belugundu
2.   C.S.Krishnamoorthy, (2002), Finite Element Analysis, Tata McGraw Hill Publishing Co. Ltd.
3.   The Finite Element Method in Engineering Science" by Zienkiewicz, P., McGraw Hill, 1971.
4.   Introduction to Finite Element Method by Desai,C.S.and Abel, J.F.,Van Nostrand, 1972.

GT 2.6 a) MARINE SUBSTRUCTURES

Introduction, Coastal Protection works – Seawall – Groins – Structural aspects – Sand dunes – Vegetation – Beach nourishment.

 Break waters – Types – Selection of site and type – Effects on the beach – Design principles of Rubble mound, vertical wall and composite Breakwaters – Stability of Rubble Structures.

 Wharves and Jetties – Types – Materials of Construction – Design Principles – Deck for fenders – Types – Design.

Dolphins – Mooring Accessories.

Submarine Pipelines – Route selection and Diameter / wall thickness calculations; Pipeline stability, free span calculations; Concrete coated pipelines and pipe-in-pipe insulated pipelines; Design using DNV 81 code.

Introduction: Offshore definition, Purpose of Offshore Structures, Classification and Examples, Various types of Offshore Structures – Jacket Platforms, Semi submersibles, Tension Leg Platforms, Gravity Platforms Guyed Towers, Articulated Towers.

Load Calculations: Environmental loads on offshore structures due to a)Wind b) Wave c) Current d) Ice e) Earth quake, Functional loads, Buoyant Forces, Installation forces, Soil structure interaction.

Wave force calculation on a Jacket platform and Semi submersible.

Preliminary design aspects of offshore structures. Construction, Towing and installation procedure of Jacket platforms and Gravity platforms.

GT 2.6 b) FORENSIC GEOTECHNICAL ENGINEERING

Concept of Forensic Investigation, Necessity, Objectives of Forensic Geotechnical Investigation, Methods of Forensic Investigation.

Project reconnaissance and characterization of the distress, including document search such as plans, codes, and other technical specifications followed in the original design.

Diagnostic tests – Analysis of field data – selection of laboratory tests based on actual field parameters to evaluate the behaviour of soil/ground.

Scope and extent of application of Forensic Engineering techniques in geotechnical and foundation failure investigations, settlement of structures, expansive soils, lateral movement, other geotechnical and foundation problems, groundwater and moisture problems.

Back analysis: Selection of theoretical model - methods of analysis, Instrumentation and Monitoring Development of the most probable failure hypothesis - cross-check with original design.

Performing reliability checks, Legal issues involving jurisprudence system, insurance, repairs, reducing potential liability, responsibility of geotechnical engineers and contractors.

References:
1.   Robert W. Day, "Forensic Geotechnical and Foundation Engineering" Mc Graw Hill.
2.   Malcolm D. Bolton, "A Guide to Soil Mechanics "Universities Press

GT 2.6 c) GEOTECHNICS OF UNDERGROUND STRUCTURES

Arching in soils, prerequisites and features of arching, Theory of arching in soils, Application of arching in cohesive frictional and cohesive-drictional soils.

Soil pressures on conduits- Loads on ditch, negative and positive projecting conduits, Bedding conditions for conduits and types of conduits, Pressures in silos, Janssen's theory for pressures in silos

Stresses in Vicinity of Vertical Shafts, Tunnels, Construction of Erath Tunnels

Retaining Systems for Underground Excavations

Braced Cuts: Lateral Earth pressure on Sheeting, Types of Sheeting and Bracing Systems, Design of Braced Cuts

Tie Backs: Components, advantages over Braced Cuts, Design concepts

Soil Nailing: Components of nailing system, Driven and Grouted Nails, Design of nailing system, anchored Spider Netting . Types of Anchorage Systems for anchored Sheet pile walls, Design of anchorages, considerations in positioning of anchorages

References:
1.   Leonards, G.A (1962) "Foundation Engineering", Mc Graw Hill Co.
2.   Shamsher Prakash, Gopal Ranjan and Swami Saran (1987) "Analysis and Design of Foundations and Retaining Structures", Sarita prakasha.

GT 2.7 DESIGN PROJECT

The students should carry out typical foundation design under varying soil conditions or revision of IS codes & IRC guidelines or any project suggested by course instructor.   The design project may consist of
1.   Soil and Structural Design of Combined footings, rafts
2.   Design of Pile Groups
3.   Design of Laterally loaded Piles
4.   Design of well Foundations
5.   Landfill Design
6.   Reinforced Soil Structures
7.   Design of Bulk heads
8.   Case studies.

GT 2.8. SEMINAR

Each student has to select a topic and collect about 10 papers with at least 5 journal papers and prepare a report and give a seminar at the end of the semester

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Scheme of Instruction and Examination
(with effect from 2015-16 academic year)

I – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
HCH1.1	Advanced Mathematics	4	--	4	3	70	30	100	4
HCH1.2	Advanced Fluid Mechanics	4	--	4	3	70	30	100	4
HCH1.3	Wave Hydrodynamics	4	--	4	3	70	30	100	4
HCH1.4	Hydrology & Water Resources Engineering	4	--	4	3	70	30	100	4
HCH1.5	a) Irrigation Water Systems and Management b) Watershed Management c) Environmental Hydraulics	4	--	4	3	70	30	100	4
HCH1.6	a) Remote sensing & GIS b)Structural Dynamics c) Urban Storm Water Drainage	4	--	4	3	70	30	100	4
HCH1.7	Computer Programming of Numerical Methods	--	3	3	Viva	50	50	100	2
HCH1.8	Hydraulics & Coastal Engineering Lab.		3	3	Viva	50	50	100	2
Total		**24**	**6**	**30**		**520**	**280**	**800**	**28**

II – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
HCH2.1	Free Surface Flow	4	--	4	3	70	30	100	4
HCH2.2	Hydraulic Structures	4	--	4	3	70	30	100	4
HCH2.3	Siting and Planning of Port & Harbour Installations	4	--	4	3	70	30	100	4
HCH2.4	Marine and Offshore Structures	4	--	4	3	70	30	100	4
HCH2.5	a) Seismic Design of Port Structures b) Water Resources systems analysis c) Finite Element Methods of Analysis	4	--	4	3	70	30	100	4
HCH2.6	a)Design of Offshore structures b) Estuarine Hydraulics c) Groundwater Hydraulics	4	--	4	3	70	30	100	4
HCH2.7	Sediment Transport & Dredging	--	3	3	Viva	50	50	100	2
HCH2.8	Seminar		3	3	Viva	50	50	100	2
Total		**24**	**6**	**30**		**520**	**280**	**800**	**28**

III and IV SEMESTERS

Code No	Course title	Scheme of Examination	Total Marks	Credits
HCH3.1	Dissertation (Preliminary)	Viva-voce	**100**	**10**
HCH4.1	Dissertation (Final)	Defence and Viva-voce	**100**	**14**

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I – SEMESTER

HCH 1.1 ADVANCED MATHEMATICS

Conformal Mappings: Analytic functions-Transformations-Some Standard Transformations: Translation, Rotation, Magnification, Inversion-Bilinear Transformation-Conformal Transformation – Special Conformal Transformations: $w = z^2$, $w = z + \dfrac{1}{z}$, $w = e^z$, $w = \cosh z$.

Vector Calculus: Green's Theorem, Stokes Theorem, Gauss-Divergence Theorem and simple applications. Applications to Partial Differential Equations: Method of separation of variables-PDE's of Engineering: Vibrations of a stretched string-Wave equation-One dimensional Heat flow-Two dimensional Heat flow-Solutions of Laplace equation-Laplace equation in polar co-ordinates.

Numerical Solutions of Ordinary Differential Equations: Introduction to Initial and Boundary Value Problems-Numerical solutions of Ordinary Differential Equations: Taylor's series, Euler's method, Modified Euler's method, Runge-Kutta methods (second and fourth orders)-Predictor-Corrector methods.
Boundary Value Problems: Finite difference method.

Numerical Solutions of Partial Differential equations: Classification of Second order equations-Finite difference approximation to derivatives-Elliptic equations –Solution of Laplace's equation: Liebmann's iteration process-Solution to Poisson's equation-Parabolic equations-Solution of one dimensional heat equation: Bender-Schmidt method, Crank Nicholson difference method-Solution of two dimensional heat equation: ADE method- Hyperbolic equations-Solution of wave equation.

Statistical Analysis: Introduction to Random Variables - Binomial distribution - Poisson's distribution-Normal distributions - Weibull distribution - Correlation-Regression Analysis.

References:
1.   Numerical Methods for Engineers by Steven C. Chapra and Raymond P. Canale, 6th Edition, McGraw Hill Publications.
2.   Numerical Methods in Engineering and Science by B.S. Grewal, 5th Edition, Khanna Publishers.
3.   Introductory Methods of Numerical Analysis by S.S. Sastry, 4th Edition, PHI Learning Private Limited.
4.   Numerical Methods (Problems and Solutions) by M.K. Jain, S.R.K. Iyengar, R.K. Jain, Revised 2nd Edition, New Age International (P) Ltd.

HCH 1.2 ADVANCED FLUID MECHANICS

Two dimensional Irrotational Flow: Standard Pattern of Two Dimensional Flows – Uniform flow, Source, Sink, Vortex and Doublet – Spiral Vortex – Flow Past a Half Body – Flow Past a Cylinder with and without Circulation – Flow Past a Rankine Body.

Laminar Flow: Introduction – Transformation – Relationship among Stresses – Relationship between Stresses and Deformations- Navier Stokes equations – Simple Examples of Exact Solution – Poiseuille Flow – Couette Flow – Combination of Poiseuille and Couette Flow – Establishment of Simple Flows – Non linear Exact Solutions – Flow between Convergent and Divergent Plates – Flow against a Normal Wall – Approximate Solutions – Flow past a sphere – Laminar stability Parameter – Analysis of laminar stability – Experimental investigation on laminar stability.

Laminar Boundary Layer: Introduction to the boundary layer – Thickness – Displacement, momentum and energy thickness – Boundary layer equations – Boundary layer along a Flat Plate with Zero Pressure Gradient (Blassius Solution) – Boundary layer Integral Momentum Equation – Transition of Turbulence.

Turbulent Flow: Definitions – Wall Turbulence and Free Turbulence – Isotropic and homogeneous Turbulence – Turbulence intensity and scale and their measures – micro scale and integral scale – Correlations – Lagrangian and Eulerian description of the flow field – Reynolds Equations – Energy and Momentum Equations and Illustration of their Application by the example of Hydraulic Jump – Phenomenological theories – Turbulent Boundary Layer Along a Flat Plat – Momentum Equation – Turbulent flow in pipes – Pipe Resistance Factor – Boundary Layer Separation – Wake Behind Cylinder – Simple Example of Free Turbulence Shear Flows.

References:
1. Applied Hydrodynamics, Valentine, H.R., Butterworth's Scientific Publications.
2. Engineering Fluid Mechanics Vols. I and II, Narasimhan, S., Orient Longman. .
3. Boundary layer theory – H. Schlichting.
4. Elementary Mechanics of Fluid – Rouse.
5. Hydraulic Machines by P. Kumar, BSP Books PVT Ltd

HCH 1.3 WAVE HYDRODYNAMICS

The basics for the application of potential theory to water wave problems – General governing equations – Bernoulli's generalized equation and general boundary conditions.

Approximating the governing equations based on physical reasoning – solutions of linear equation for progressive and standing waves – Pressure velocity fields – Surface profile and dispersion relationship – Principle of super position – wave energy, energy flux and energy principle – Group velocity.

Various perturbation schemes for solving water wave problems – Stokes' wave – Derivation of second order governing equations and outline of their solution – Mass transport and the

momentum principle (radiation stresses) – Limitations of the Stokes' solution – Cnoidal waves and Solitary waves – Wave breaking Criteria.

Wave refraction – Graphical techniques – wave diffraction around breakwater and through breakwater gaps. Wind generated wave – Some Statistical aspects, Rayleigh distribution wave heights, the wave spectrum and Mathematical spectrum models – PM, JANSWOP etc. – Wave forecasting using SMB's significant wave height method and PNJ wave spectrum method.

Wave forces on piles – Basic assumptions – Values of the inertia and drag coefficients and their dependence on the wave theory used.

Beach and shoreline development – Deltas, Head lands and Estuaries – Water movement in near shore area Sources and characteristics of materials – Littoral transport – Contribution by streams – Contribution by erosion or coastal formation; Modes of Littoral Transport – Depths at which material moves – Determination of direction and direction variability – Rates of Littoral Transport – Losses of Littoral Material.

Text Books/References:
1.   Shore Protection Manual (CEM), U.S. Army Coastal Engineering Research Centre.
2.   Estuary and Coastline Hydrodynamics, Ippen, A.T., Iowa State University Press.
3.   Coastal Engineering Vols. I & II, Silvester, R., Elsevier Scientific Publishing Co.
4.   Oceanographical Engineering, Wiegel, R.R., Prentice Hall Inc.
5.   Wind Waves and Maritime Structures, Minikin, R.R.,Charles Griffin & Co.
6.   Coastal Hydraulics, Muir Wood,A.M. and C.A.Fleming,John Wiley and Sons.
7.   Coastal Processes with Engineering Applications, Robert, A. D., Cambridge University Press.
8.   Coastal Hydrodynamics, Mani., J.S.,PHI Learning Pvt. Ltd

HCH 1.4 HYDROLOGY & WATER RESOURCES ENGINEERING

Part A : Hydrology

Runoff: Runoff process – Unit hydrograph – Derivation and analysis – S-hydrograph – Synthetic unit hydrograph-Instantaneous Unit hydrograph – methods of determining IUH – conceptual models of IUH – Formulation of models – concept of linear reservoir, models of Nash and Dooge and Kulandaiswamy; Nonlinearity of runoff-distribution – Overland flow steam flow – Flow duration and mass curves and Time series analysis.

Floods: Importance of flood studies – definition, causes of floods, seasonal distribution of floods, design flood, factors affecting flood flow; magnitude and frequency of floods – empirical, probability and unit hydrograph methods; Flood control Measures: Flood control reservoirs – Types, location, size – levees and flood walls – stage reduction and reduction in peak discharge flood routing through reservoirs.

Part B : Water Resources Engineering

Introduction to Water Resources: Hydrological Cycle – Characteristics – Surface and ground water resources – quality conservation and flood control; Water Resources Planning – Purpose of water resources development, classification of water Resources Development Projects, Functional Requirements of Multipurpose Projects, Process of Project Formulation, Project Evaluation, Strategies for the Future, Planning Strategies, Management Strategies.

Climate Change on Water Resources: Climate and Weather, The vital importance of monsoon rains, Clouds, Storms and Precipitation, Influences and feedbacks of hydrological changes on climate, Observed climate change impacts, Future changes in water availability and demand due to climate change, Climate related drivers of freshwater systems in the future, Impacts of climate change on water stress in the future, Freshwater areas and sectors highly vulnerable to climate change, potential water resource conflicts between adaptation and mitigation.

Site investigations and design aspects of Water Resources: Surface water resources –Minor tanks, Reservoirs, Diversion head works; Ground water resources – Tube wells, Open wells.

Rainwater Harvesting: Rainwater harvesting, Artificial recharge of ground water.

Application of Remote Sensing (RS) and Geographical Information System (GIS) in Water Resource: A brief history of RS, Sensor systems used in RS, RS Satellites, Landsat, and IRS. Remote Sensing applications in Civil Engineering projects GIS over view, GIS components, Raster data models and Vector data model, Application of RS and GIS in water resources Engineering.

References:
1.   Hydrology, Wisler, C.O. and E.F. Brater, John Wiley and Sons..
2.   Geo-Hydrology, De Wiest, R.J.M., John Wiley and Sons.
3.   Hydrology for Engineers, Linsley, R.K., M.A. Kohler and J.L.H. Paulus McGraw-Hill.
4.   Water Resources Engineering, Linsely, R.K., J.B. Franzini, D.L. Freyberg and G. Tchobanoglous, McGraw- Hill Publishing Co.; 4th edition.
5.   Irrigation Engineering and Hydraulic Structures, Garg S.K. Khanna Publishers.
6.   Principles of Geographical Information Systems for land resource assessment, Burrough, P.A., Clarendon press, Oxford.
7.   Remote Sensing in Civil Engineering, Kennie, J.M. and M.C. Matthews McGraw-Hill.
8.   Remote Sensing: Principles and Interpretation, Sabins F.F.,Waveland Pr Inc, 3rd Edition.
9.   Impacts of climate change and climate variability on hydrological regimes, Jan C. van Dam, Cambridge University Press.
10. IPCC fourth assessment report- The AR4 synthesis report
11. IPCC fourth assessment report- Working Group I report, The physical Science Basis.
12. IPCC fourth assessment report- Working Group II report, Impacts, Adaptation and vulnerability.
13. IPCC fourth assessment report- Working Group III report, Mitigation of Climate Change.

HCH 1.5 (a) IRRIGATION WATER SYSTEMS AND MANAGEMENT

Irrigation systems – Major, mini, minor potential surface, lift and GW systems, methods of irrigation, relative merits and demerits, modeling

Soil physics and Soil chemistry; terminology; Soil-water and hydraulic conductivity. Soil chemical properties- impact of soil and water chemical concentrations on yields –management of soil chemical concentrations.
Soil physics and Soil Agriculture, cropping pattern, irrigation, sustainable systems

Planning irrigation systems – crop water requirements, irrigation frequency, yield – Methods of estimation of crop water requirements – methods based on temperature and pan evaporation; combined method; crop coefficient curves.
Surface system design: definitions –furrow system design – level basin system design –graded border system design

Sprinkler System Design: Uniformity and adequacy of water application-evaporation and wind drift- components of system design. Distribution system design and layout- centre pivot system, linear move system- Big gun and Boom sprinkler systems.

Trickle (Drip) irrigation system design: Concept of trickle system- Emitters – flow through laterals – filtration and water treatment systems- fertilizer injection systems.

Water logging and prevention and efficiencies. Optimization techniques in planning as applied to Irrigation.

Agricultural hydrology, subsurface, unsaturated flow, hysterisis, soil moisture and deep percolation, return flows and modeling droughts and mitigation of droughts.

Text Books:
1.   Chaturvedi,Water Resources Systems Planning and Management , M.C. Tata McGraw Hill
2.   James L.D and Lee R.R, Economics of Water Resources Planning, McGraw Hill
3.   Maiche,l Irrigation theory & Practise
4.   Richard H. Cuenea, Irrigation System Design (An engineering approach), Prentice Hall
5.   Deniel P. Louchs, Jerry R. Stedinger and Danglass. A. Haith, Water resources systems planning and analysis , Prentice Hall

Reference Books:
1.   Irstelsen and Hanesn, Irrigation – Principles and methods
2.   Mays L.W. and Tung Y.K.,Hydrosystems Engineering and Management McGraw Hill,
3.   Ossenburgen P.J., Systems analysis for Civil Engineer,   John Wiley and Sons, Publication of NW, Roorkee

HCH 1.5 (b) WATERSHED MANAGEMENT

Watershed management concept: introduction, concept of watershed management, history of watershed management and its relevance to india, watershed characteristics; climatic characteristics, physiographic characteristics, causes of watershed deterioration, effect of watershed on the community, water resources region of India

Principles of watershed management: integrated watershed management approach (IWMA); objectives of IWMA, envisaged results, success criteria, selection of watershed village, equity issues for watershed policies, factors causing the inequality, benchmark survey, remote sensing survey in watershed management, land capability classification.

Soil erosion: introduction, soil erosion, factors affecting soil erosion, different types and causes of erosion- geologic erosion, accelerated erosion, estimation of loss of soil from erosion, soil loss models, sediment models, bed load models, control of soil erosion

Management of natural drainages: introduction, check dam, structures for gully stabilization and storage of water, rivers or stream bank management measures in watershed, river training works, methods of river training works

Wasteland and land drainage management: introduction, causes of wasteland – water logging, salinity, soil erosion, overgrazing, mining operation, industrial effluent, brickfields, inadequate surface and subsurface drainages, remedial measures in wasteland management, land drainage management- surface or overland drains, subsurface or underground drains, discharge and spacing of tile drain.

Flood damage mitigation management: introduction, mitigation measures, structural mitigation measures, non-structural mitigation measures, flood plain zoning, flood forecasting.
Water harvesting: introduction, techniques of water harvesting, indigenous water harvesting methods in India, engineering methods of water harvesting.

Watershed modelling: introduction, data of watershed for modeling, application of watershed models, model calibration and validation

Text books:
1.   Madan mohan das, Mimi das Saikia, "watershed management", PHI learning pvt. Ltd.,
Reference books:
1.   Murty, J.V.S., Watershed Management, New Age Intl., New Delhi 1998.
2.   Allam, G.I.Y., Decision Support System for Integrated Watershed Management, Colorado State University, 1994.
3.   Vir Singh, R., Watershed Planning and Management, Yash Publishing House, Bikaner,
4.   American Society of Civil Engineers, Watershed Management, American Soc. of Civil Engineers, New York, 1975.

HCH 1.5 (c) ENVIRONMENTAL HYDRAULICS

Hydrology: Statistical analysis of Hydrological Data -, Intensity–Duration frequency Curves. Hydraulics of groundwater flow: Non–equilibrium flow, Yield estimations, Interferences Infiltration galleries, ground water recharge

Transportation and distribution of water: Storage capacity, Pumping of Water, Design and selection of economical diameter of pumping main. Distribution of Water - Pressure and capacity requirements of distribution system, Analysis of networks, Appurtenances in a distribution layout, detection and prevention of leakage mains.

Hydraulics of Sewers: Design of sewers in full and partial flow conditions, Flow at Sewer transitions, Sewage pumping. Open channel flow–design of open channel flow sections.

Transport phenomenon – diffusion – dispersion – advection – adsorption - conservative and non-conservative pollutants. Governing Equations for flow and transport in surface and subsurface waters-chemical and biological process models-simplified models for lakes, streams, and estuaries.

Modelling of the transport phenomenon: complexity - coupled and uncoupled models – linear and nonlinear models - Solution techniques – calibration. Numerical models: FDM, FEM and Finite volume techniques - explicit vs. implicit methods - numerical errors. Different types of Stream quality modeling and Groundwater transport modeling.

References :
6.	Water and waste water Engineering by Fair Gayer and Okun
7.	Engineering Hydrology by K. Subramanya, Tata McGraw-Hill Education
8.	Hydrodynamics of transport for water quality modeling by Martin, L.J. and McCucheon, S.C, Lewis Publishers.
9.	Groundwater by Freeze, R.A. and Cherry. J.A. Prentice Hall,
10.	Groundwater Hydrology by Todd, Wiley Publications

HCH 1.6 (a) REMOTE SENSING AND GIS APPLICATIONS

Introduction; Definition, Principle Of Remote Sensing, History Of Development Of Remote Sensing, Stages In Remote Sensing, Electromagnetic Radiation And The Electromagnetic Spectrum, Interactions With The Atmosphere, Atmospheric Scattering, Atmospheric Absorption, Atmospheric Windows, Refraction, Interaction Of EMR With The Earth's Surface, Reflection, Transmission, Spectral Signature.

Platforms & Sensors: Remote Sensing Systems, Remote Sensing From Space, Remote Sensing Sensors, Resolution, Imaging Sensors, Optical Infrared (OIR) Imagers, Optical Sensors, Thermal Sensors, Microwave Sensors, Active Microwave Sensors, Data Preprocessing, Remote Sensing In India.

Introduction To Image Interpretation; Basic Principles Of Image Interpretation, Elements Of Image Interpretation, Techniques Of Image Interpretation, Interpretation Keys, Introduction To Digital Image Processing: Digital Image- Image Rectification And Registration- Geometric Correction, Image Enhancement Techniques (Only Concepts), Image Classification - Unsupervised Classification And Supervised Classification. Digital Photogrammetry - Stereo Images From Satellites - Data Merging .

Geographic Information Systems (GIS); Definitions And Related Technology, GIS Operations, GIS Elements, GIS Concepts And Practice, Map Projection And Coordinate System.
Vector Data Model: Introduction, Vector Data Representation, Geometric Objects, Topology.
Vector Data Analysis: Introduction, Buffering, Applications Of Buffering, Map Overlay, Feature Type And Map Overlay, Map Overlay Methods, Slivers, Error Propagation In Map , Overlay, Distance Measurement, Map Manipulation,

Raster Data Analysis: Introduction, Analysis Environment, Local Operations, Local Operations With A Single Grid, Local Operations With Multiple Grids, Neighborhood Operations, Zonal Operations.

Terrain Mapping And Analysis: Introduction, Data For Terrain Mapping And Analysis, Surface Models-DEM, TIN.

GIS Models And Modeling: Introduction, GIS Modeling, Binary Models, Index Models
Remote Sensing & GIS Application In Civil Engineering – Some Case Studies From Literature.

Text Books :
1.   Fundamentals Of Remote Sensing 2nd Ed – George Joseph, University Press, New Delhi.
2.   Introduction To Geographic Information Systems – Kang Tsung Chang, Tata Mc.G.H. Publications, New Delhi.
3.   Lillesand, T.M. And Kieffer, Remote Sensing And Image Interpretation, Joh Wiley And Sons, New York, 1987.

Reference Books:
1.   Remote Sensing Of The Environment – An Earth Resource Prespective – John R. Jensen, Pearson Education, New Delhi.
2.   Aronoff, S. 1989. Geographic Information Systems: A Management Perspective. Ottawa: Wdl Publications.
3.   Bonham – Carter, G,F. 1994. Geographic Information Systems For Geoscientists: Modeling With Gis. New York: Pergamon Press.
4.   Burrough, P.A And R.A. Mcdonnell. 1998. Principles Of Geographical Information
5.   Systems. Oxford: Oxford University Press.
6.   Lo, C.P., And Albert K.W. Young Concepts And Technologies Of Geographic Information Systems, Prentice Hall Of India (Pvt) Ltd, New Delhi.
7.   John R Jensen : Introductory Digital Image Processing , Prentice Hall, New Jersey.
8.   Farsworth, R.K., Bawetl, E.C. & Dhanju, M.S., Application Of Remote Sensing To Hydrology Including Groundwater, IHP, UNESCO, 1984.

HCH 1.6 (b) STRUCTURAL DYNAMICS

One Degree Systems: Undamped systems, Various forcing functions damped systems, Response to pulsating force, Support motion.

Lumped Mass Multi-degree System: Direct determination of natural frequencies, Characteristic shapes, Stodola-Vianelle method, Modified Rayleigh-Ritz method, Lagrange's equation, Model analysis of multi degree systems, Multi-storey rigid frames subjected to lateral loads, Damping in multi degree systems.

Structures with distributed mass and load, Single span beams, Normal modes of vibration, Forced vibrations of beams, Beams with variable cross-section and mass.

Approximate design methods, Idealized system, Transformation factors, Dynamic reactions response calculations, Design example (RC beam, Steel beam and RC slab), Approximate design of multi degree systems.

Matrix Approach: Coordinates and lumped masses, Consistent mass matrix, Undamped force vibration of a system with one degree freedom, Response of single degree freedom undamped system, Viscous damped vibration of a single degree freedom system, Undamped vibration of multi degree freedom system, Orthogonality of natural nodes, Normal coordinates.

Books:
1.   "Structural Dynamics" by John M. Biggs.
2.   "Structural Analysis" by A. Ghali & A.M. Neville
3.   Structural Dynamics by Paz, Springer publishing Pvt Ltd

HCH 1.6 (c) URBAN STORM WATER DRAINAGE

Introduction to drainage problems in different climates: Urbanisation, its effects and consequences for drainage-interaction between urban and peri-urban areas Process of urbanisation and influence on hydrologic cycle

Planning concepts and system planning: Objectives of urban drainage and planning criteria, drainage and system layout. Planning tools and data requirement, drainage master plan, examples for drainage structures.

Review of Hydrologic and hydraulic principles: Urban hydrologic cycle, hydrologic principles, Rainfall analysis in Urban environment and design storm, hydraulic principles, hydrodynamic principles.

Urban Runoff computations : Empirical, Time-area and unit hydrograph approaches

Design of drainage system elements: Hydraulic fundamentals, infiltration and on-site detention of stormwater, design of sewerage and drainage channels, design of appurtenances, road drainage, design of pumping stations.

Control of stormwater pollution: Pollution build-up and washoff process with reference to urban drainage systems. Source control in commercial and industrial complexes, storage options - dry and wet ponds, biological treatment of wastewater, chemical treatment of stormwater.
Operation and maintenance of urban drainage systems: Maintenance requirement for different structures, maintenance planning, cleaning of sewers and drains, inventory of damages, repair options.

Urban drainage : Kinematic wave theory approach

Introduction to urban watershed softwares Hydrologic Cistern, water conservation and ecological aspects Water harvesting

Text-books:
1.   Chow, V.T., Handbook of Applied Hydrology : A Compendium of Water resources
2.   Gupta, R.S., Hydrology and hydraulic systems, Prentice Hall, Englewood cliffs,
3.   Urban Hydrology : Hall, M.J.
4.   Hydrology : Viesmann & Knapp

HCH 1.7 COMPUTER PROGRAMMING OF NUMERICAL METHODS

Introduction to Programming and Flow Charts: Digital and analog computers functional organisation of a digital computer – counting – techniques binary – binary – numbers storage and retrieval of information – programming language – applicability of Fortran – flow chart concept – few examples.

Arithmetic Expressions and Statements: Arithmetic expressions – Fortran constants – Integer, real and complex constants – Fortran variables – Integer and real variables – rules regarding the meaning of variables and use of operation of symbols – Hierarchy of arithmetic operations – Use of parenthesis and rules regarding parenthesis – Arithmetic statements built-in functions.

Input Output and Format Statements: Input output devices – rules punching a card – the data card – Read statement Data initialization statement – Specification statement varieties – F, E, I and A Formats – Blank field specification – carriage control – punching of format statements – Use of coding sheets.

Control Statements: Unconditional and conditional control statements – small programmes.

Subscripted Variables: Subscripted variables – rules regarding subscripted variables – Dimension statement – general form – Do statement – general form – continue statement – rules regarding do statements and nested do loops – Equivalence statements – small programmes.

Sub-Programming: Subroutines sub-programme statements – rules regarding subroutine sub-programmes – call statements – common statement – rules regarding common statement – examples with small programmes.

Some Aspects of Fortran 90: Declaration statements – logical constants and variables – relational operators and expressions – logical operators and expressions – logical assignments – statements – logical IF statement – complex variable and expressions – library functions – control cards – Examples with programmes.

Programming of Numerical Methods: Calculation of mean, variance and correlation coefficient – linear regression – simple linear programming – Matrix inversion by Partitioning method linear interpolation – Taylor's series – Real roots by iteration – Newton-Raphson method – von Mises method – Chord method – Bisection method. Numerical differentiation and integration – Simpson's 1/3 rule, Trapezoidal rule – Milne's predictor corrector method to solve first and second order differential equations – Runge Kutta method.

Programming of Some Hydraulics and Coastal Engineering Problems: Hydrograph Analysis, Stress Analysis of Gravity and Earth Dams, Wave Reflection Analysis (Two Probe and Three Probe Methods), Computation of wave force on a cylinder and a wall, Best Hydraulic Section, GVF Surface profile Computations, Bed and Suspended Sediment Load Computations.

References:
1.   Computer Programming in FORTRAN 90 & 95, Rajaraman,V., PHI Learning Pvt. Ltd.
2.   Numerical Methods and FORTRAN Programming: with applications in engineering and science, Daniel, D.M. and S.D. William, Wiley.
3.   Numerical methods in Fortran, McCormick, J. M. and M. G. Salvadori Prentice Hall.

HCH 1.8 HYDRAULICS AND COASTAL ENGINEERING LABORATORY

1.   Study of pressure distribution and D/S profiles over a spillway.
2.   Study of measurement of velocities using a Pitot tube and current meter in open channel.
3.   Study of a Venturiflume.
4.   Study of measurement of regular and random waves - Calibration of instruments for the measurement of waves.
5.   Study of measurement of wave height, wave length and wave period.
6.   Study of measurement of wave reflection from beach and transmission through/over the structures.
7.   Study of measurement of wave force on a cylindrical member.
8.   Study of measurement of displacement of a floating body under waves.

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Syllabus
(with effect from 2015-16 academic year)

II – SEMESTER

HCH 2.1 FREE SURFACE FLOW

Introduction: Classification of flows, velocity distribution, pressure distribution, Derivation of the general one-dimensional equations of continuity, energy and momentum used in open channel flow analysis.

Steady Uniform flow and non-uniform flows: Chezy's equation, Manning's formulae, uniform flow computations – Hydraulically efficient channel section, design of irrigation channels, specific energy, specific force, critical depth, calculation of critical depth, applications of specific energy, channel transitions and controls, hydraulic jumps, surges.

Gradually varied flow: Surface profile for gradually varied flow.

Unsteady flow in open channels: Method of characteristics, surge formation. Kinematics of waves, flood routing and overhead flow.

Inland navigation: Introduction, Various Requirements of Navigable Waterways, Various Measures Adopted for Achieving Navigability, India's Navigable Waterways.

River Engineering: Classification of Rivers, Causes of Meandering, The Aggrading type of River, Degrading type of River, Cutoffs, River Training, Types of Training Works.

References:
1. Flow in Open Channels, Subramanya, K., Tata McGraw-Hill Publishing Co. Ltd.
2. Flow through Open Channels by K.G. Ranga Raju, Tata McGraw-Hill Publishing
3. Open Channel Flow, Henderson, F.M.,Macmillan series in Civil Engineering.
4. Open Channel Hydraulics, Chow, V.T.,McGraw-Hill Ltd.
5. Engineering Hydraulics, Rouse, H., John Wiley & Sons Inc.
6. Open-Channel Flow by, Hanif Choudhury, M., Prentice Hall of India.
7. Irrigation and Hydraulic structures, Garg, S.K., Khanna Publishers.
8. Irrigation and Water Power Engineering, Punmia, B.C. and P.B.B. Lal, Laxmi Publications Pvt. Ltd

HCH 2.2 HYDRAULIC STRUCTURES

Dams: Types, Choice of type of dam, Forces acting on dams, Requirements of stability, Causes of failure.

Gravity dams: Non-overflow and overflow types, Modes of failure and criteria for structural stability of gravity dams, Design of gravity dam, Single step and multistep design, Cracks and joints in a gravity dam, Foundation treatment for gravity dams, Stress concentration around openings in dams, gravity dams subjected to earthquakes.

Spillways: Different types of spillways and their design principles, Energy dissipation below spillways, Use of hydraulic jump as energy dissipater and design of stilling basins, Types of spillway gates.

Arch dams: Types, loads on arch dams, Cylinder theory – Constant radius, Constant angle, Variable radius types, and Principles of elastic theory and Trial load method of analysis.

Buttress dams: Components, Advantages and Disadvantages, Types, Forces, Theory of buttress design, Buttress spacing and buttress construction details.

Earth dams: Types of earth dams, Methods of construction, Causes of failure of earth dam, Design criteria for earth dams, Selecting a suitable section for an earth dam, Requirements of safety, Seepage, Construction of seepage line for different conditions, Seepage control methods, Stability analysis for different conditions, Factor of safety against foundation shear, Details of method of construction of earth dams, Maintenance and treatment of common troubles in earth dams.

Appurtenance works: Design principles of various types of crest gates, Stilling basins, and drainage galleries.What hammer analysis and design of surge tanks, Penstocks, Draft tubes and Scroll casing.

References :
1. Theory and Design of Irrigation Structures Vol. I & II, 7th edition, Varshney, R.S., S.C. Gupta and Gupta, R.L.,Nem Chand & Brothers.
2. Irrigation: Practice and Design – Vols. II & III, Khushalani, K.B. and M Khushalani, Oxford of IBH Publishing Co
3. Irrigation and Hydraulic structures, Garg, S.K., Khanna Publishers.
4. Engineering for Dams – Vols. I, II & III, Creager, W.P, J.D. Justin and J. Hinds,John Wiley & Sons.
5. Hand Book of Applied Hydraulics, Davis, C.V. and K.E.Sorensen, Third Edition, McGraw-Hill Book Co

HCH 2.3 SITING AND PLANNING OF PORT AND HARBOUR INSTALLATIONS

History of port growth – Factors affecting growth of port.

Classification of Harbours – Planning of a port – Ship characteristics as they relate to port planning – Need and economic justification of a port – Volume and type of commerce – Hinterland studies and growth.

Meteorological, Hydrographic and oceanographic data required for port design – Determination of best location of a harbour to afford maximum protection, minimum maintenance and facilities for expansion.

Size and shape of harbour and turning basin – Type, location and height of Breakwaters – Location and width of entrance to harbour – Depth of harbour and navigational channel – Number, location and type of docks or berths or jetties.

Shore facilities for Marine terminals and fishing harbours.

References:
1. Dock and Harbour Engineering Vols. I, II & III, Cornick, H.F.,Charles Griffin & Co.
2. Design & Construction of ports and Marine structures, Quinn, A.D.F.,McGraw-Hill.
3. Port Engineering, Brunn, P., Gulf Publishing Co.

HCH 2.4: MARINE AND OFFSHORE STRUCTURES

Introduction, Coastal Protection works – Seawall – Groins – Structural aspects – Sand dunes – Vegetation – Beach nourishment.

Break waters – Types – Selection of site and type – Effects on the beach – Design principles of Rubble mound, vertical wall and composite Breakwaters – Stability of Rubble Structures.

Wharves and Jetties – Types – Materials of Construction – Design Principles – Deck for fenders – Types – Design.

Dolphins – Mooring Accessories.

Submarine Pipelines – Route selection and Diameter / wall thickness calculations; Pipeline stability, free span calculations; Concrete coated pipelines and pipe-in-pipe insulated pipelines; Design using DNV 81 code.

Introduction: Offshore definition, Purpose of Offshore Structures, Classification and Examples, Various types of Offshore Structures – Jacket Platforms, Semi submersibles, Tension Leg Platforms, Gravity Platforms Guyed Towers, Articulated Towers.

Load Calculations:Environmental loads on offshore structures due to a)Wind b) Wave c) Current d) Ice e) Earth quake, Functional loads, Buoyant Forces. Installation forces, Soil structure interaction. Wave force calculation on a Jacket platform and Semi submersible.

Preliminary design aspects of offshore structures, Construction, Towing and installation procedure of Jacket platforms and Gravity platforms.

Text Books/Reference Books:
1. Hydrodynamics of Offshore structures, Chakrabarthi, S.K., WIT Press / Computational Mechanics.
2. Mechanics of Wave Forces on Offshore structures, Turgut Sarpkaya & M. Issacson, Van Nostrand Reinhold Co.
3. Structural Engineering, Dawson, T.H.,Offshore Prentice Hall Inc Englewood Cliffs, N.J.
4. Dynamic Analysis of Offshore Structures, Brebia, C.A and S. Walker, New Butterworths, U.K.
5. API, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms, American Petroleum Institute Publication.

HCH 2.5 (a) SEISMIC DESIGN OF PORT STRUCTURES

Earthquake and Port Structures: Introduction, earthquake motion, liquefaction, tsunamis, port structures, some examples of seismic damages.

Design Philosophy: Performance based designs, reference levels of earthquake motions, performance evaluation.

Damage criteria: gravity quay walls, sheet pile quay walls, pile supported wharves, cellular quay walls, quay walls with cranes, breakwaters.

Seismic Analysis: Types of analyses, site response/ liquefaction analysis, analysis of port structures, input and output of analysis.

Existing codes and guidelines

References:
1. Bowles, J.E. (1997). Foundation Analysis and Design; Fifth Edition 2012; McGraw-Hill Companies Inc N.Y. USA.
2. Ministry of Transport, Japan (ed) (1999). Design Standard for Port and Harbour Facilities and Commentaries, Japan Port and Harbour Association (in Japanese). ; English edition (2001) by the Overseas Coastal Area Development Institute of Japan.
3. PIANC (2011), Seismic Design Guidelines for Port Structures, Working Group No. 34 of the Maritime Navigation Commission, International Navigation Association, A.A. Balkema, Rotterdam, The Netherlands.

HCH 2.5 (b) WATER RESOURCE SYSTEMS ANALYSIS

System concepts: Definition, classification, and characteristics of systems - Scope and steps in systems engineering - Need for systems approach to water resources and irrigation.

Linear programming: Introduction to operations research - Linear programming, problem formulation, graphical solution, solution by simplex method - Sensitivity analysis, application to design and operation of reservoir, single and multipurpose development plans - Case studies.

Dynamic programming: Bellman's optimality criteria, problem formulation and solutions - Application to design and operation of reservoirs, Single and multipurpose reservoir development plans - Case studies.

Simulation: Basic principles and concepts - Random variant and random process - Monte Carlo techniques - Model development - Inputs and outputs - Single and multipurpose reservoir simulation models - Case studies.

Advanced optimization techniques: Integer and parametric linear programming - Goal programming models with applications Discrete differential dynamic programming and incremental dynamic programming - Linear decision rule models with application - Stochastic dynamic programming models.

References:
1. Daniel P. Loucks and Eelco van Beek, "Water Resources Systems Planning and Management- An Introduction to Methods, Models and Applications", United Nations Educational, Scientific and Cultural Organization, 7, place de Fontenoy F-75352 Paris 07 SP, 2005.
2. Gupta P.K and Man Mohan, "Problems in Operations Research (Methods and solutions)". Sultan Chand and sons, New Delhi, 1995.
3. Hiller F.S and Liebermann G.J., "Operations Research" CBS Publications and distributions. New Delhi, 1992.
4. Chaturvedi. M.C., "Water Resources Systems Planning and Management". Tata McGraw Hill, New Delhi, 1997.
5. Mays L.W., and Tung YK, "Hydro systems Engineering and Management". McGraw Hill Inc., New York, 1992.
6. Wagner H.M., "Principles of Operations Research with Application to Management Decisions", Prentice Hall, India, New Delhi, 1993.

HCH 2.5 (c) FINITE ELEMENT METHODS OF ANALYSIS

Introduction: A brief history of F.E.M. Need of the method, Review of basic principles of solid mechanics- Equations of equilibrium, Boundary conditions, Compatibility, Strain displacement relations, Constitutive relationship in matrix form, plane stress & plane strain and axisymmetric bodies of revolution with axi-symmetric loading, Energy principles - Raleigh - Ritz method of functional approximation.

Theory relating to the formulation of the finite element method, Coordinate system (local and global), generalized coordinates, Concept of the element, Various element shapes, Discretisation of a structure, Mesh refinement Vs. Higher order element, Interconnections at nodes of displacement models, inter element compatibility, -shape functions.

Basic component – One dimensional FEM single bar element, Beam element : Derivation of stiffness matrix, Assembly of stiffness, Matrix boundary conditions, shape functions for 1 D elements, Initial strain and temperature effects, and trusses under axial forces.

Two dimensional FEM: Different types of elements for plane stress and plane strain analysis – Displacement models Generation of element stiffness and nodal load matrices –static condensation.

Isoperimetric representation and its formulation for 2d analysis. Formulation of 4-noded and 8-noded isoparametric quadrilateral elements – Lagrangian elements-serendipity elements.

References :

1. Introduction to Finite element Method by Tirupathi chandra Patla and Belugundu
2. C.S.Krishnamoorthy, (2002), Finite Element Analysis, Tata McGraw Hill Publishing Co.
3. The Finite Element Method in Engineering Science" by Zienkiewicz, P., McGraw Hill,
4. Introduction to Finite Element Method by Desai,C.S.and Abel, J.F.,Van Nostrand, 1972.

HCH 2.6 (a) DESIGN OF OFFSHORE STRUCTURES

Introduction: Offshore definition, Purpose of Offshore Structures, Classification and Examples, Various types of Offshore Structures – Jacket Platforms, Semi submersibles, Tension Leg Platforms, Gravity Platforms Guyed Towers, Articulated Towers. Materials used in offshore structures; elements of hydrodynamics and wave theory-fluid structure interaction.

Load Calculations: I. Environmental loads on offshore structures due to (a) Wind, Wave, Current, Ice and Earth quake- II. Functional loads - III. Buoyant Forces - IV. Installation forces. Design Wave heights and Spectral Definition; Hydrodynamic Coefficients and Marine growth; Fatigue Load. Wave forces on vertical and inclined cylinders, Wave force calculation on Jacket platforms.

Analysis of Offshore structural member using matrix methods: plane truss, plane frame and space frame. Static method of analysis and dynamics of offshore structures. Use of approximate methods - Design of structural elements. Principles of Static and dynamic analyses of fixed platforms, Analysis of Jacket plat form under wave loading.

Dynamic Analysis: Introduction to dynamic analysis and calculation of responses of semisubmersible and TLP's under wave loading.

Preliminary design aspects of offshore structures: Construction, Towing and installation procedure of Jacket platforms and Gravity platforms.

Steel Tubular Member Design: Introduction to tubular joints - Possible modes of failure - Eccentric connections and offset connections Principles of ASD and LRFD; Allowable stresses and Partial Safety Factors; Tubular Members, Slenderness effects; Column Buckling, Design for Hydrostatic pressure; Design for combined axial and bending stresses (API RP 2A guidelines). Simple tubular joints design using allowable loads; stress concentration factors; Fatigue of tubular joints - Fatigue behavior; S-N curves and fatigue damage calculations.

Text Books/Reference Books:
1. Hydrodynamics of Offshore structures, Chakrabarthi, S.K., WIT Press / Computational Mechanics.
2. Mechanics of Wave Forces on Offshore structures, Turgut Sarpkaya & M. Issacson, Van Nostrand Reinhold Co.
3. Structural Engineering, Dawson, T.H.,Offshore Prentice Hall Inc Englewood Cliffs, N.J.

4. Dynamic Analysis of Offshore Structures, Brebia, C.A and S. Walker, New Butterworths, U.K.
5. API, Recommended Practice for Planning, Designing and Constructing Fixed Offshore Platforms, American Petroleum Institute Publication.

HCH 2.6 (b) ESTUARINE HYDRAULICS

Introduction to estuaries in general, Morphological and geological features. Salinity gradients, Tide propagation and associated currents.

Estuaries classifications, Estuarine residual circulation theories and application.

Sediment processes (turbidity maximum and fluid mud).

Long-term morphodynamic evolution, Physical processes and management.

Case studies (from literature).

Text books:
1. Estuary and coastline hydrodynamics / Arthur T. Ippen [editor]., New York : McGraw-Hill Book Co.

HCH 2.6 (c) GROUNDWATER HYDRAULICS

Introduction: Hydrologic cycle, Movement & occurrence of groundwater, properties of groundwater, general flow equations, Dupuit equation

Fundamentals of Groundwater Flow :Occurrence of Ground Water, Vertical Distribution of G.W., Darcy's Law, Permeability, Porosity, Anisotropic Aquifers, Differential equations of G.W. flow.

Potential Flow: Flownets, Boundary conditions, Flow-net construction for confined & unconfined flow systems.

Mechanics of Well Flow: Steady & unsteady flow in confined & unconfined aquifers, Leaky aquifers, Partial penetration of wells, Multiple well systems, Boundary effects & method of images, Well Loses.

Groundwater Modelling: Sand Tank, Heleshaw, Electrical analogous models, Finite Element/Difference models.

Groundwater Development and Management: Design of wells, construction of wells, Well Development, Artificial recharge, Conjunctive use, Salinity of G.W.,

Groundwater pollution. Sources & type of groundwater contamination, Contaminant transport mechanisms: Advection, Diffusion & dispersion, Mass transport equations, one & two-dimensional modeling

Sorption & other chemical reactions: factors affecting sorption, Sorption isotherms, Sorption effect on fate & transport of pollutants, Estimation of sorption

Biodegradation reactions & kinetics: biological transformations, microbial dynamics, kinetics of biodegradation

Nonaqueous-phase liquids: Types of NAPLs, general processes, NAPL transport computational methods

Groundwater remediation and design: Remedial alternatives, source control, hydraulic controls, bioremediation, soil vapor extraction systems, remediating NAPL sites, emerging technologies

Text books:
2. Rifai & Newell, Ground Water Contamination, Transport and Remediation by Bedient, , PTR Prentice Hall
3. D.K. Todd, groundwater hydrology, john wiley & sons
4. M.E. Harr, Groundwater and Seepage.

HCH 2.7 SEDIMENT TRANSPORT & DREDGING

1. Study of basics of sediment transport phenomenon.
2. Estimation of bed load &suspended load and Reservoir Siltation
3. Sediment samplers and sampling: Bed load sampling, suspended load sampling and computation of total load.
4. Dredging and Disposal of dredged materials.
5. Case studies of Reservoir siltation.
6. Case studies of Dredging in ports and harbours.

References:
1. Mechanics of Sediment Transportation and Alluvial steam problems, Garde, R.J. and K.G. Ranga Raju, Second Edition, Wiley Eastern Limited.
2. Hydraulics of Sediment Transport, Graf, W.H., McGraw-Hill Book Co.
3. Loose Boundary Hydraulics, Raudkivi, A.J.,Pergamon press.
4. Practical Dredging, Cooper, H.R., Brown, Son & Ferguson, Glasgow.
5. Dock and Harbour Engineering Vols. I, II & III, Cornick, H.F., Charles Griffin & Co.
6. Dock and Harbour Engineering, Seetharaman, S. Umesh Publication.

HCH 2.8 SEMINAR

Each student has to select a topic and collect about 10 papers with at least 5 journal papers and prepare a report and give a seminar at the end of the semester

Department Of Civil Engineering
M TECH. (CONSTRUCTION TECHNOLOGY AND PROJECT MANAGEMENT)
Scheme of Instruction and Examination
(with effect from 2015-16 academic year)

I – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
CTPM1.1	Principles of Construction Management	4	--	4	3	70	30	100	4
CTPM1.2	Construction Planning and Scheduling	4	--	4	3	70	30	100	4
CTPM1.3	Construction Equipment and Methods	4	--	4	3	70	30	100	4
CTPM1.4	Environmental Impact Assessment and Auditing	4	--	4	3	70	30	100	4
CTPM1.5	a) Advanced Foundation Engineering b) Computer Aided Design and Applications c) Urban Transportation Planning	4	--	4	3	70	30	100	4
CTPM1.6	a) Advanced Concrete Technology b) Reliability Analysis and Design c)Construction Economics and Accounting	4	--	4	3	70	30	100	4
CTPM1.7	Computer applications in Structural Engineering	--	3	3	Viva	50	50	100	2
CTPM1.8	Construction Engineering Laboratory		3	3	Viva	50	50	100	2
Total		**24**	**6**	**30**		**520**	**280**	**800**	**28**

II – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
CTPM2.1	Project Administration	4	--	4	3	70	30	100	4
CTPM2.2	Contracts and Legal Issues	4	--	4	3	70	30	100	4
CTPM2.3	Safety Management	4	--	4	3	70	30	100	4
CTPM2.4	Management Information Systems	4	--	4	3	70	30	100	4
CTPM2.5	a) Ground Improvement Techniques b) Operations Research c) Strategic management of construction projects	4	--	4	3	70	30	100	4
CTPM2.6	a) Prestressed Concrete b) Disaster Management c)Infrastructure Valuation	4	--	4	3	70	30	100	4
CTPM2.7	Repair and Rehabilitation of Structures	--	3	3	Viva	50	50	100	2
CTPM2.8	Case Studies		3	3	Viva	50	50	100	2
Total		**24**	**6**	**30**		**520**	**280**	**800**	**28**

III and IV SEMESTERS

Code No	Course title	Scheme of Examination	Total Marks	Credits
CTPM3.1	Dissertation (Preliminary)	Viva-voce	**100**	**10**
CTPM4.1	Dissertation (Final)	Defence and Viva-voce	**100**	**14**

Department Of Civil Engineering
M TECH. (CONSTRUCTION TECHNOLOGY AND MANAGEMENT)
Syllabus
(with effect from 2015-16 academic year)

I – SEMESTER

CTPM 1.1: PRINCIPLES OF CONSTRUCTION MANAGEMENT

Introduction, Major problems in Construction Industry, History of Construction Management, Functions and Responsibilities of Construction Manager, Case Studies, Future of Construction Management.

Decision Making in Construction Industry – Benefit-Cost Analysis, Replacement Analysis, Break Even Analysis, Risk Management in Construction Industry.

Value Engineering, Definition, Fundamentals of Value Engineering, Life Cycle Costing, Delphi Technique and Uses of Value Engineering – Its applications to Construction Industry.

Concept of Safety in Construction Industry, Importance of Construction Safety, Safety Benefits to Employers, Employees and Customers, Construction Safety Problems, Approaches to improve Construction Safety.

Management Information and Control Systems, Communication, System Concepts, Need for Management Information, Design of Management Information Systems, Computer Processing, Value of Information, Management Information Systems in Construction Industry.

References :
1. "Construction Management and Practice." Raina, C.M. Tata McGraw-Hill,
2. The Construction Management Process" Tenah, K.A. (1985) Reston Publishing Company, Inc. Virginia, U.S.A.
3. Construction Management by Williams, Cengage publishing Pvt Ltd
4. Construction Project Management by Fewings, Taylor and Francis publishing Pvt Ltd

CTPM 1.2: CONSTRUCTION PLANNING AND SCHEDULING

Introduction to Project Management, Project Planning, Scheduling and Controlling- Introduction to methods of planning and scheduling.

Bar charts and Milestone Charts – Development of Bar charts – Shortcomings – Remedial measures – Milestone charts. PERT- Elements of Networks – Event, Activity, and Dummy Activity – Guidelines for the construction of the network – Development of PERT network – Numbering - Fulkerson's rule - Skip numbering.

Time estimates – Optimistic, Pessimistic and Most likely time estimates – Earliest Expected time and Latest Allowable Occurrence time. Critical Path – Slack – Identification of Critical Path – Probability of Completion of projects.

CPM – Construction of network – Earliest Possible Occurrence time and Latest Possible Occurrence time – Start and Finish times of activities – Floats – Identification of Critical Path using floats.

Cost Analysis – Direct and Indirect project costs – Total costs – Cost Slopes – Crashing - Cost and Time Optimization.

Updating – Data required for updating – Process of updating – When to update.

Resource allocation – Resources – Usage profiles – Histograms – Resource Smoothing – Resource leveling.

References:
1.   PERT and CPM – BC Punmia and KK Khandelwal
2.   PERT and CPM – LS Srinath.
3.   A management guide to PERT/CPM by Wiest Levy, PHI Publications

CTPM 1.3 : CONSTRUCTION EQUIPMENT AND METHODS

Skills related to Construction Management will be covered in a laboratory setting including plan reading, specification reading, construction scheduling and estimating using industry standard state-of-the-art software and hardware, and other applied tasks.
Course Description: Study of construction operations as dynamic production processes. Utilization of equipment and other resources to achieve highest levels of productivity, safety, and quality. Covers a wide range of traditional and state-of-the-art construction methods.
Working of GPS and Total Stations for road alignment, project lay out and marking. Particulars of related Software.
Description and Working of equipment related to Earth Work, Concrete, Road Laying. Attachments components parts – Compactors, Crances, Crawler Loaders, Dozers, Drills, Dumpets, Excavagtors, Forklifts, Graders, Hoists, Lifts, Loader Backhoe, mixers, Pavers, Rollers, Scrapers, Skid Steer Loaders, Skidders, Trucks, Truck (Off Highway), Wheel Loaders and others.
Equipment related to repairs rehabilitation and renovation.

References :
    1. Construction Materials, Methods and Techniques by Spence, Cengage publishing Pvt Ltd
    2. Construction Planning, Equipment, Methods by Pensifoy, Scheznayder, Tata McGraw Hill Publication

CTPM 1.4:: ENVIRONMENTAL IMPACT ASSESSMENT

Concept of Environment – Definition of EIA and EIS – Elements of EIA – Guidelines for the preparation of EIS – Governmental policies for environmental protection.

Environmental setting – Environmental attributes – air, water, soil, noise, ecological, social, economical, cultural, human and aesthetic aspects – Environmental indices.

Methodology for the identification of Impacts – Criteria for the selection of methods – Methodologies- Adhoc, checklist, Overlaying, Matrix and Network methods.

Prediction and Assessment of Impacts on – air, water, soil, noise, ecological, social, economical, cultural, human environments and aesthetic aspects.

Review of Environmental Impact Statement – Cost benefit analysis – Measures for environmental impact mitigation and control – Case Studies.

References
1. Environmental Impact Analysis – Urban and Jain.
2. Environmental Impact Analysis – Canter.
3. Environmental Impact Assessment Methodologies by Y Anjaneyulu, and Valli Manikkam, BSP Books PVT Ltd
4. Environmental Impact Assessment by Anji Reddy, BSP Books PVT Ltd

CTPM 1.5 a) ADVANCED FOUNDATION ENGINEERING

Introduction: Principles of Design of Foundations, Types of shear failures in foundation soils, Types of foundations, Design Loads, Basic Concepts of safe and allowable bearing capacity.Shallow Foundations

Bearing Capacity Analysis: Bearing capacity theories – Terzaghi, Meyerhof, Skempton, Hansen, Vesic and IS Methods, Bearing capacity evaluation from Standard Penetration test and Plate load test.

Settlement Analysis: Uniform and Differential Settlements, Elastic and Consolidation Settlements, Settlement analysis in cohesion less soils by Schemartmann and Hartman method, Penetration tests; Permissible settlements as per IS 1904-1978, causes of settlement, settlement Control.

Proportioning of footings: Isolated column footings, Strip, combined Footings and Strap Footing.

Raft Foundations: Bearing capacity of raft foundation, floating raft, Types of rafts, Beam on Elastic foundation and Conventional methods of Design, determination of modulus of subgrade reaction.

Deep Foundations : Pile Foundations: Types, load capacity- dynamic formulae, static formula; pile load tests- Vertical load test, lateral load test, Cyclic load test; settlement of piles and pile groups, negative skin friction on single pile and pile groups; laterally loaded piles - Broom's Analysis, IS Code method; Under reamed piles – Load capacity, design and construction.

Well Foundations: Types, Bearing Capacity of well foundations, Construction of pneumatic caissons, Tilts and Shifts: precautions, Remedial measures; Lateral stability analysis by Terzaghi's Method, Design aspects of Components of well foundation.

Foundations in Expansive Solis : Introduction, Identification of expansive soils, Swell potential and swelling pressure, Active depth, Foundation Problems, Foundation practices in expansive soils, Soil Replacement and 'CNS' concepts.

Foundations of Transmission Line Towers : Introduction, Necessary information, Forces on tower foundations, General design criteria, Choice and type of foundation, Design procedure.

Reference Books:
1. Foundation Analysis and Design by J.E. Bowles, Mc Graw Hill Publishing Co.
2. Foundation Design by W.C. Teng, John Wiley, New York.
3. Analysis and Design of Substructures by Swami Saran, Oxford &IBH Publishing Co.
4. Foundation Engineering by P.C. Vargheese, Prentice Hall of India
5. Basic and Applied Soil Mechanics by Gopal Ranjan and A.S.R. Rao, New Age International Publications

CTPM 1.5 (b) : COMPUTER AIDED DESIGN AND APPLICATIONS

Introduction: Computer Systems, Computer specifications, peripherals, computer language and developments, concepts of programming, flow charts, algorithms and debugging.

C-Language: C-Character set, identifiers and keywords, data types, constants, variables, arrays, declarations, expressions, statement and symbolic constants, Data input and output. Arithmetic, unary and relational operators, expressions, assignment and conditional operators, library functions, control statements and functions.

File Management: File management, Pointers and their applications, structures and pointers, arrays and strings, processing of arrays.

Object Oriented programming: Introduction to object oriented programming, basic concepts of object oriented programming and its advantages.

Computer Graphics: Introduction, Devices and world co-ordinates, transformation principles, windowing and clipping, display devices, graphics input devices, graphical input techniques, realism in graphics, geometric modeling, drafting and computer graphics in CAD.

Civil Engineering Applications : Preparing and running complete programs in C for Civil Engineering problems such as analysis of beams, trusses and determinate frames, deign of pipes, pavements and footings, slope stability analysis and construction engineering problems – exposure to graphics primitives.

Computer Aided Design: Computer aided design of civil engineering problems such as plane frame and space frame analysis and construction engineering and management problem – exposure to software packages such as NISA & STAD-PRO.

References :
1."Computer Aided Design" by C.S. Krishna Murthy & S. Rajeev, Narosa Pub., 1993.
2."Computer Applications in Construction", Boyd C. Panbou, Tata McGraw-Hill, 1997.

CTPM 1.5 (c) - URBAN TRANSPORTATION PLANNING

Travel Demand Concept: Demand function: Independent variables: Travel attributes; Assumptions in Travel demand estimation; Sequential, Sequential recursive and Simultaneous process.

Data Collection And Inventories: Study area definition; Zoning principles; Travel data collection - Road side interview, Home interview; IPT surveys; Sampling techniques; Expansion factors; Use of Secondary sources in data collection.

Travel Demand Estimation: Four step Travel Demand Forecasting approach; Trip generation Analysis; Zonal models Category analysis; Household models; Trip attraction of work centres.

Trip Distribution: Mode Factor methods; Gravity model; opportunity model.

Mode Split Analysis: Mode choice behavior ; Computing modes; Diversion curves; Probabilistic approaches.

Traffic Assignment: Traffic network and coding; Minimum path trees; All or nothing assignment; Capacity restraint assignment; Corridor Identification; Plan preparation and Evaluation; Deficienc analysis.

References:
1. Introduction to Transportation Planning - M.J.Bruton; Hutchinson cf London Ltd.
2. Introduction to Urban System Planning - B.G.Hutchinson; Mc Gra Hill.
3. Urban Transportation Planning Guide - Roads & Transportation AS~C(i<:tion of Canada; University of Toronto Press.
4. Traffic Engineering and Transport Planning - Kadiyali L.R. Khanna Publis
5. Lecture notes on UTP - Prof. S.Raghavachari, R.E.C. Warangal

CTPM 1.6 a): ADVANCED CONCRETE TECHNOLOGY

Durability of concrete and concrete construction: Durability concept, pore structure and transport processes, reinforcement corrosion, fire resistance, frost damage, sulphate attack, alkali silica reaction, delayed ettringite formation, methods of providing durable concrete, short-term tests to assess long-term behaviour.

Mix design: Review of methods and philosophies of IS, BS and ACI methods, mix design for special purposes. Acceptance criteria for compressive strength of concrete

Special concretes: Lightweight concrete, autoclaved aerated concrete, no-fines concrete, lightweight aggregate concrete and foamed concrete, High strength concrete, refractory concrete, high density and radiation-shielding concrete, polymer concrete, fibre-reinforced concrete, mortars, renders, recycled concrete, Ferro Cement, Self Compacting Concrete.

Special processes and technology for particular types of structure: Sprayed concrete, underwater concrete, grouts, grouting and grouted concrete, mass concrete, slip form construction, pumped concrete, concrete for liquid retaining structures, vacuum process, concrete coatings and surface treatments.

Test methods: Analysis of fresh concrete, Accelerated testing methods, Tests on hardened concrete, Core cutting and testing, partially destructive testing, Non-destructive testing of concrete structures

References:
1. Properties of Concrete, A.M.Neville, Longman 1995.
2. Concrete micro-structure, Properties and Materials, P.K.Mehta, J.M.Monteiro, Printice Hall INC & McGraw hill, USA.
3. Concrete Technology Theory and Practice, M.S.Shetty, S.Chand & Company Ltd, New Delhi.

CTPM 1.6 b) RELIABILITY ANALYSIS AND DESIGN

Concepts of Structural Safety: General, Design methods.

Basic Statistics: Introduction, Data reduction, Histograms, Sample correlation.

Probability Theory: Introduction, Random events, Random variables, Functions of random variables, Moments and expectation, Common probability distribution, Extremal distribution.

Resistance Distributions and Parameters: Introduction, Statistics of properties of concrete, Statistics of properties of steel, Statistics of strength of bricks and mortar, Dimensional variations, Characterization of variables, Allowable stresses based on specified reliability.

Probabilistic Analysis of Loads: Gravity loads, Wind load.

Basic Structural Reliability: Introduction, Computation of structural reliability. Monte Carlo Study of Structural Safety: General, Monte Carlo method, Applications.

Level 2 Reliability Methods: Introduction, Basic variables and failure surface, First-order second-moment methods (FOSM).

Reliability Based Design: Introduction, Determination of partial safety factors, Safety checking formats, Development of reliability based design criteria, Optimal safety factors, Summary of results of study for Indian standard – RCC design. Reliability of Structural Systems: Preliminary concepts as applied to simple structures.

References:
1. "Structural Reliability Analysis and Design" by Ranganatham, R.
2. "Structural Reliability" by Melchers, R.E.

CTPM 1.6 c) CONSTRUCTION ECONOMICS AND ACCOUNTING

Construction accounting-income statement-depreciation and amortization.

Engineering economics-benefit-cost analysis-replacement analysis-break even analysis-assessment of time for arriving break even.

Risks and uncertainties and management decision in capital budgeting-Uncertainties due to improper planning.

Taxation and inflation-work pricing-contract bidding and award-revision-escalation.

Turnkey activities-project appraisal and yield-Working capital management-international finance-budgeting and budgetary-performance-appraisal.

Text Books:
1. Danny myers,construction economics: A new approach,Taylor and francis publisher,2004.
2. Ofori,G, the construction industry aspects of its economics and management, Singapore university press,1990.

CTPM 1.7– COMPUTER APPLICATIONS IN STRUCTURAL ENGINEERING

Application of software's in Structural Engineering (by using STAAD Pro,ETABS, STRAP, STRUDS etc) for the following problems.

1. Analysis and Design of Beams.
2. Analysis and Design of Footings.
3. Analysis and Design of Trusses.
4. Analysis and Design of Two Dimensional Frames.
5. Analysis and Design of Three Dimensional Frames.
6. Analysis and Design of Water Tanks.
7. Analysis and Design of Steel Members.
8. Implementation of Concepts of FEM using a Computer Language

CTPM 1.8 : CONSTRUCTION ENGINEERING LABORATORY

Concrete Mix Design – by BIS, ACI and BS method – proportioning, Batching, Mixing, Moulding of specimens for compression, Modulus of Elasticity and Modulus of Rupture – Testing of specimens as per relevant of practice (comparative study).

Development of correlation between Non-Destructive and Destructive Tests using Rebound Hammer & UPV instruments.

Influence of following parameters on NDT readings – experimental observations.

Aggregate – Cement ratio, Water Cement Ratio, Excess / Deficient Cement, Excess / Deficient Water, Aggregate Type.

Strain and deflection measurement for a structural member under single point / two point loading crack propagation observation, measurement and plotting.

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II – SEMESTER

CTPM 2.1 : PROJECT ADMINISTRATION

Construction Administration, Control of Quality in Construction, Organizational Structure, Design Build Contracts, Responsibility for Coordination of the trades.

Lines of Authority on Construction Projects, Responsibility, Familiarization with construction documents, Staffing Responsibilities.

Certainty, Risk and Uncertainty, Risk Management, Identification and Nature of Construction Risks, Contractual allocations of Risk, Types of Risks, Minimizing risks and mitigating losses, use of expected values, utility in investment decisions, decision trees, sensitivity analysis.

Preconstruction Operations – Constructability Analysis, Issuance of Bidding Documents, Prequalification of Bidders, Bonds, Opening Acceptance and Documentation of Bids.

References:
1. "Construction Project Administration," Fisk, E.R. (2000) Prentice hall International, London.
2. "Construction Project Administration," Kwakye, A.A. (1977) Adission Wesley Longman, London.

CTPM 2.2 : CONTRACTS AND LEGAL ISSUES

Execution of Works – Direct execution by Department – Muster Roll (form 21) – Piece work agreement – Work Order. Execution through contractor – Definitions – Types of contracts – Lump sum contract, Item rate contract, Cost plus fixed fee contract, Cost plus percentage contract, Special contracts.
Contract document – Conditions of Contract – Tender notice – Bidding procedure – Scrutiny and acceptance of tender, award of contract – Earnest money deposit and Security deposit - Termination of contract. Disputes – Settlement through arbitration – Indian Arbitration Act 1940 – Clauses and advantages of arbitration.

Specifications – Importance, Design and Writing of Specifications – Types of Specifications – General, Detailed, Standard, Special, Restricted and Manufacturer's specifications.

Accounts – Advances, Earnest money and Security deposits, First and final bills, Fines, Recovery, Closing of accounts.

Labour legislation – Factory Act 1948, Contract Labour Act 1970, Trade Union Act, Minimum Wages Act 1948, Workmen Compensation Act 1923, Industrial Disputes Act 1947. Labour Welfare – Labour welfare fund act 1965, Employees State Insurance act 1948, Incentives, Labour welfare measures.

References:
1.   Construction Management and Accounts – BL Gupta and Amit Gupta
2.   Construction Management and Projects – B Sengupta and H Guha
3.   Construction Planning and Management – PS Gelhot and BM Dhir.

CTPM 2.3 : SAFEY MANAGEMENT

Safety management function, line versus staff authority, safety responsibility and accountability in construction industry.

Safety and its importance in construction industry, hazards in construction projects, causes of accidents, cost of an accident.

Experience Modification Rating, Workers insurance, general safety programs in construction industry, construction safety problems.

Case based reasoning, case indexing, retrieval, accident prevention and forecasting using CBR method.

Systems safety analysis, faulty tree analysis, failure modes and effects analysis in construction industry.

References:
1."Safety Management". John V. Grimaldi, (1996).   AITBS Publishers & Distributors, New Delhi, India.
2."Construction Project Administration". Kwakye, A.A. (1997), Adisson Wesley Longman, London.

CTPM 2.4: MANAGEMENT INFORMATION SYSTEMS

Importance of Management Information Systems (MIS), Logical Foundation of MIS, Manger's View of Information systems, Functions of Management, managerial role, Activities of an Construction Organization.

Management and Decision Making in Construction Industry, Classification of Information Systems and Impact of construction work on Management Information Systems.

Strategic Uses of Information Technology, Inter Organizational Systems, Strategic Information Systems related to Construction Industry.

Information Technology, Role of Information Technology in Construction Industry, Impact of Information Technology on the Individuals, Impact on the Construction Organization and Process of Reengineering Work.

File Structures and Processing methods in Construction Organizations, Data base Concepts, An Data Base management systems.

References :
1. "Management Information Systems - The Manager's View". Robert Schultheis, Mary Sumner. (1999).Tate McGraw Hill Edition, New Delhi.
2. "Construction Project Administration", Kwakye, A.A.(1997), Adisson Wesley Longman, London.
3. Management Information Systems by Sumner, Tata McGraw Hill Publication

CTPM 2.5 a) GROUND IMPROVEMENT TECHNIQUES

Compaction: Theory of compaction, Shallow Surface Compaction - Equipment, Placement water content, factors affecting shallow compaction; Deep compaction: Methods - Vibrofloatation, Terra probe method, Pounding, Blasting, Compaction piles; Compaction Control.

Vertical Drains: Sand drains, Sand wicks, Rope drains, Design of vertical drains, Stone columns, application of the techniques to Marine clays.

Stabilization: Introduction, objectives, Methods of stabilization – Mechanical, Cement, Lime, Bituminous, Calcium chloride; construction methods, factors affecting stabilization of soils; Deep Mixing methods – Soil lime Columns and Cement Lime Columns, applications

Dewatering: Definition, necessity, Methods of dewatering – Interceptor ditch, Single, Multistage and Vacuum well points, Horizontal wells, Electro-osmosis. Permanent drainage by Foundation drains and Blanket drains.

Grouting: Definition, Objectives of grouting, Grouts and their properties, Categories of Grouting, Grouting methods: Asending, Descending and Stage Grouting in Soils, Hydrofracture, Grouting Equipment, Post grouting tests.

In-situ Reinforcement: Ground Anchors, Tiebacks and Soil Nailing, Micropiles.

Reference Books:
1. Engineering Principles of Ground Modification by Monfred R Hausmann, Mc Graw Hill Publishing Co.
2. Ground Improvement Techniques by P. Purushothama Raj, Laksmi Publications, New Delhi

CTPM 2.5 b) OPERATIONS RESEARCH

Linear programming Introduction& problem formulation.

Graphical solutions - SIMPLEX method

Duality in Linear programming.

Transportation problem

Assignment and routing problem.

Queuing theory.

References:
1.   Operation research by Kanti Swarup, Gupta and Manmohan.
2.   Operation research and statistical analysis by S.D.Sharma
3.   Operations Research by Ranganath, Yes Dee publishing Pvt Ltd

CTPM 2.5 c) STRATEGIC MANAGEMENT OF CONSTRUCTION PROJECTS

Introduction to Strategic Management Concepts-necessity and significance of strategic management.

Different approaches of Strategy Formation and Implementation-procedures- problems encountered.

External and Internal Environment Analysis.

Financial Strategies-budget allocation for different tasks -Decision and Analytical Tools.

Corporate Strategic Events, Leadership and Decision-making, Corporate Social Responsibility.

Text Books:
1.   David Langford, Steven Male, Strategic Management in Construction, 2nd Edition, John Wiley and Sons, 2008.
2.   Richard Fellows, Construction Management in Practice, 2nd Edition, Blackwell Science,

CTPM 2.6 a) - PRESTRESSED CONCRETE

Introduction: Basic concepts of prestressing need for high strength steel and concrete, advantages of prestressed concrete. Materials for prestressed concrete, high strength concrete and high strength steel.

Prestressing systems and losses of prestress: (1) Freyssinet Anchorage System (2) Gifford Udall System (3) Magnel-Blaton System, Tensioning devices, anchoring devices. (d) Pretensioning and Post tensioning. Prestressing losses, Elastic shortening, loss due to shrinkage, loss due to creep, loss due to friction, loss due to slip etc. I.S.code provisions.

Analysis of prestressed Concrete Beams: Assumptions, Analysis of prestress, Resultant stresses at a section, pressure or thrust line, concept of load balancing, cable profile, kern distance, stress in tendons as per IS 1343, cracking moment.

Shear and Torsional Resistance of Prestressed Concrete Members: Shear and Principal Stresses, Ultimate Shear Resistance of Prestressed Concrete Members, Design of Shear Reinforcements, Prestressed Concrete members In Torsion, Design of Reinforcements for Torsion, Shear and Bending

Transfer of prestress in Pretensioned members: Transmission length, bond stress, Transverse tensile stress, End Zone reinforcement, flexural bond stress, I.S. Code Provisions.

Anchorage zone in post tensioned members: Introduction, stress distribution in End block, Investigation on Anchorage Zone Stresses- Magnel's method, Guyon's method of approach of analysis of end block (Not more than 2 cables).

Deflection of Prestressed Concrete Members: Importance of Control of Deflections, Factors Influencing Deflections, Short-Term Deflection of Uncracked members, Prediction of Long Time Deflections, Deflection of Cracked Members, Requirements of various Codes of Practice.

Text Book:
  1. Prestressed Concrete by N.Krishna Raju.
References:
  1.   Prestressed Concrete by N.Rajagopalan.
  2.   Prestressed Concrete by P. Dayaratnam.
  3.   Design of Prestressed Concrete Structures by T.Y. Lin and Ned. H. Burns.

CTPM 2.6 b) DISASTER MANAGEMENT

Introduction, Disaster Management ,Hazards and Disasters: Earthquake Risk Management, Tsunami Risk Reduction, Flood Risk Management, Cyclone Risk Management, Drought Risk Management, Post-tsunami Hazards along the Indian Coast.

Risk and Vulnerability: Building Codes and Land Use Planning, Social Vulnerability, Macro-economic Management and Sustainable Development ,Environmental Vulnerability and Disaster Risk Reduction ,Climate Change Risk Reduction, Financial Management of Disaster – related

Economic Losses.

Disaster Reduction Technology: Implementation Technology for Disaster Reduction, Disaster Management for Infrastructure, Geospatial Information in Agricultural Drought Assessment and Monitoring, Multimedia Technology in Disaster risk Management Training, Transferable Indigenous Knowledge in Disaster Reduction.

Education and Community: Education in Disaster Risk Reduction, Essential of School Disaster Education, Community Capacity and Disaster Resilience, Community-based Disaster Recovery, Community-based Disaster Management and Social Capital, Designing Resilience.

Crosscutting Issues: Disaster, Environment and Development, Impact of Disasters on Poverty and Deprivation, Climate Change adaptation and Human Health, Exposure, Health Hazards and Environmental Risk. Hydro-meteorological disasters and Agriculture, Forest Management and Disaster Risk Reduction.

Rural Livelihood and Disaster Risk Reduction, Essentials of Urban Disaster Risk Reduction, Institutional Capacity in Disaster Management, Corporate Sector and Disaster Risk Reduction, Essentials of Pre-disaster Recovery Planning, Experiences of Disaster Risk Reduction .
 Books:
1. Disaster Management ,R.B.Singh, Rawat Publications
2. Natural Disaster Management ,Jon Ingleton
3. Disaster Management, Rajib Shaw and RR Krishnamurthy, Universities Press, Hyderabad.
4. Disaster Management by Rajib Shah, United Press
5. Disaster Management by Pandey, Wiley Publications

CTPM 2.6 c) INFRASTRUCTURE VALUATION

Function analysis; FAST diagramming; brain storming; criteria scoring matrices.

An introduction to value theory; an introduction to value management.

Value Engineering-Definition and concepts of the creative and structured phases of value engineering.

The workshop approach to achieve value- procedures- merits and demerits-detailed analysis.

Teambuilding theory; target setting; time management.

Text Books:
1. Lawrence D. Miles, Techniques of Value Analysis and Engineering, McGraw-Hill Book Company, 2009.
2. M.R.S. Murthy, Cost Analysis for Management Decisions, Tata McGraw-Hill Publishing Company Ltd.,1988.

CTPM 2.7 REPAIR AND REHABILITATION OF STRUCTURES

Materials: Construction chemicals, Mineral admixtures, Composites, Fibre reinforced concrete, High performance concrete, Polymer-impregnated concrete.

Techniques to Test the Existing Strengths: Destructive and non-destructive tests on concrete.

Repairs of Multi-storey Structures: Cracks in concrete, Possible damages to the structural element beams, Slab, Column, Footing, etc., Repairing techniques like Jack Chu, Grouting, External pre-stressing, Use of chemical admixtures, Repairs to the fire damaged structure.

Repairs to Masonry Structures & Temples: Damages to masonry structures – Repairing techniques, Damages to temples – Repairing techniques.

Foundation Problems: Settlement of soils – Repairs, Sinking of piles – Repairs.

Corrosion of Reinforcement: Preventive measures – Coatings – Use of SBR modified cementitious mortar, Epoxy resin mortar, Acrylic modified cementitious mortar, Flowing concrete.

Temporary Structures: Need for temporary structures under any Hazard, Various temporary structures, Case-studies.

Case Studies: At least 2 case studies per each student.

References:
1. "Renovation of Structures" by Perkins.
2. "Repairs of Fire Damaged Structures" by Jagadish, R.
3. "Forensic Engineering" by Raikar, R.N.
4. "Deterioration, Maintenance and Repair of Structures" by Johnson, McGraw Hill.

CTPM 2.8: CASE STUDIES

Candidates have to submit TWO case studies of construction projects of considerable size with all details related to various aspects like planning, design, construction, safety, EIA of the project, labour management, legal and other aspects etc, in a report format.

Department Of Civil Engineering
M TECH. (WATER RESOURCES ENGINEERING)
Scheme of Instruction and Examination
(with effect from 2015-16 academic year)

I – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
WRE1.1	Computational Hydraulics	4	--	4	3	70	30	100	4
WRE1.2	Channel and Fluvial Hydraulics	4	--	4	3	70	30	100	4
WRE1.3	Applied Hydrology	4	--	4	3	70	30	100	4
WRE1.4	RS and GIS applications	4	--	4	3	70	30	100	4
WRE1.5	a) Climate change and Water Resources b)Irrigation water systems and management c) Environmental Hydraulics	4	--	4	3	70	30	100	4
WRE1.6	a) Water Power Engineering b) Statistical Methods for Engineers c) Water quality	4	--	4	3	70	30	100	4
WRE1.7	Computational fluid mechanics laboratory	--	3	3	Viva	50	50	100	2
WRE1.8	GIS laboraotory		3	3	Viva	50	50	100	2
Total		**24**	**6**	**30**		**520**	**280**	**800**	**28**

II – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
WRE2.1	Watershed Management	4	--	4	3	70	30	100	4
WRE2.2	Hydraulic Structures	4	--	4	3	70	30	100	4
WRE2.3	Urban storm water Drainage	4	--	4	3	70	30	100	4
WRE2.4	Environmental impact assessment	4	--	4	3	70	30	100	4
WRE2.5	a) Water resources project management b)Finite Element Methods of Analysis c) Water Resources systems analysis	4	--	4	3	70	30	100	4
WRE2.6	a) Estuarine Hydraulics b)Sub-structure design c) Flood Modeling and Drought Assessment	4	--	4	3	70	30	100	4
WRE2.7	Hydraulics lab	--	3	3	Viva	50	50	100	2
WRE2.8	Seminar		3	3	Viva	50	50	100	2
Total		**24**	**6**	**30**		**520**	**280**	**800**	**28**

III and IV SEMESTERS

Code No	Course title	Scheme of Examination	Total Marks	Credits
WRE3.1	Dissertation (Preliminary)	Viva-voce	**100**	**10**
WRE4.1	Dissertation (Final)	Defence and Viva-voce	**100**	**14**

I – SEMESTER

WRE 1.1 COMPUTATIONAL HYDRAULICS

PART – A: Statistical Methods in Hydraulics:
Importance of statistical and Probability Analysis, Statistical variables, Frequency, Probability and Statistical Distributions for Discrete Random variables and Continuous Random Variables. Statistical Parameters –Measures of Central Tendancy, Measures of variability and measures of Skewness; Statistical moments, Statistical Homogenity –Time homogeneity and Space homogeneity.

Probability and Distributions – Basic definintions of probability – random variable- discrete probability distributions – contionuous   - distribution functions – expectation – repeated traits – binomial distribution – Poisson distribution – Normal distribution.

Reliability Analysis-Sampling Reliability and Prediction of Reliability; Theoretical Justifications- Type-I Extremal Distribution, Lognormal Distribution, Exponential Distribution and Logextremal Distribution.

Correlation and Rank correlation – Linear Regression – Multiple linear Regression – Curvilinear Regression.

PART – B: Introduction to programming language C:
Overview of C language, contracts, variables and data types. Operators and expressions. Arthimatic operators, Relational operators, logical operators, assignment operators, increments and decrements operators, conditional operators, special operators, bitwise operators. Managing input and output operations.

Decision making and branching. If statements, switch statement, conditional operator statement. Decision making and looping. While loop, Do loop, for loop, nested loops.

Arrays- single dimensional arrays. Handling character string functions. Various built in string functions.User defined functions, all kinds of functions. Structures and unions. Pointers and pointer operators. Files; file handling function sequential files, random access files.

Text books:
1.   Ven Te Chow, Handbook of Applied Hydrology, McGH Publishers.
2.   Dr. B.S. Grewal, Higher Engineering Mathematics, Khanna Publishers, Nai Sarak, Delhi.
3.   E. Balaguru Samy, Programming in ANSI C.
Reference books:
1.   Ven Te Chow Handbook of Applied Hydrology, McGH Publishers.

2.   Dr. P. Jayarami Reddy, Stochastic Hydrology, Laxmi Publications, New Delhi.
3.   R.S. Varshney, Engineering Hydrology, Nem Chand & Bros., Roorkee.
4.   Vimala and Venugopal, Programming with C.

WRE 1.2   CHANNEL & FLUVIAL HYDRAULICS

Review of Fundamentals of Hydraulics-Continuity Equation, Bernoulli's Equation and Impulse – Momentum Equation.

Introduction to Open Channel Flows- Basic Features, Uniform Flow and computation of Normal Depth, Specific Energy-Depth Relationship, Critical flow and Computation of Critical Depth, Hydraulic Jump.

Steady State Gradually-Varied Flow- Governing Differential Equation, Classification of GVF Profiles, Computation of Profiles.

Transient Gradually-Varied Flow- Saint Venant Equations, Kinematic Wave Theory, Flood routing Through Channels- Muskingum Method.

Fluvial Hydraulics, Incipient Condition, Bed Load, Suspended Load, Bed Forms & Field Measurements.

Text Books/ Reference Books:
1.   Subramanya, K., Flow in Open Channels, Tata Mc Graw Hill, 1986.
2.   Garde , R.J. and Rangaraju, K.G., Mechanics of Sediment Transport and Alluvial Stream Problems.
3.   Chow,V.T., Open Channel Hydraulics, Mc Graw Hill, Tokyo, 1959.
4.   Rangaraju, K.G., Flow through Open Channels.

WRE 1.3   APPLIED HYDROLOGY

Introduction: Hydrologic Cycle - the global phenomenon, the hydrologic model on a watershed scale, water balance, water resources and availability; History and scope of Hydrology;

Precipitation: Earth's revolution, seasons, and atmospheric circulation; Formulation, types and distribution, Presentation and processing of data – Consistency and missing data, depth, area and duration; Mean rainfall – isohyetal and trend surface methods, confidence limits and comparison of averages; Frequency analysis – normal and lognormal distributions, frequency plotting, goodness of fit, climate classification, rain gauge network;

Evaporation: Methods of calculation – energy balance, aerodynamic methods; evapo-traspiration potential; Consumptive use, water requirement of crops; soil water balance and climate.
Subsurface Water: Unsaturated flow, moisture flux, Infiltration - rates, capacity., Measurement, Horton's and Philiph's equations; Green-Ampt method, Ponding time, surface runoff and infiltration indices.

Runoff Hydrology**:** Wateshed processes; new concepts, surface runoff- Honton's flow, variable source area theory – subsurface flow – flow through matrix and pipes; Stream flow components hydrographs and separation; flow recession; unit hydro-graph theory, derivation, S-curve and applications; travel time. Catchment response, factors influencing run off..

Groundwater Hydrology: Occurrence of groundwater. Vertical distribution of groundwater, zone of aeration, zone of saturation, types of aquifers, storage coefficient. Groundwater movement; Darcy's law, permeability, hydraulic conductivity, anisotropic aquifers, groundwater flow direction.

Application of GIS for hydrological studies (introduction only)

Text books:
1. Linsely R.K and others, "Hydrology for Engineering", McGraw Hill, 1952.
2. Linsely R.K. and others, "Engineering Hydrology", McGraw Hill, 1949
3. Subramanya K., "Engineering Hydrology", Tata McGraw Hill, 1998.
Reference books:
1. Weissman (J) W. and others, "Introduction to Hydrology", Harper, and Row
2. Mutreja, K.N., "Applied Hydrology", Tata McGraw Hill, 1986
3. Chow V.T. (ed.) "Hand book of Hydrology", McGraw Hill, 1988
4. Chow V.T. and others, " Applied Hydrology", McGraw Hill, 1989
5. Hann C.T., "Statistical methods in Hydrology", A.E.W. Press, 1977

WRE 1.4 REMOTE SENSING AND GIS APPLICATIONS

Introduction; Definition, Principle of Remote Sensing, History of Development of Remote Sensing, Stages in Remote Sensing, Electromagnetic Radiation and the Electromagnetic Spectrum, Interactions with the Atmosphere, Atmospheric Scattering, Atmospheric Absorption, Atmospheric Windows, Refraction, Interaction of EMR with the Earth's Surface, Reflection, Transmission, Spectral Signature.

Platforms & sensors: Remote Sensing Systems, Remote Sensing from Space, Remote Sensing Sensors, Resolution, Imaging sensors, Optical Infrared (OIR) Imagers, Optical Sensors, Thermal Sensors, Microwave Sensors, Active Microwave Sensors, Data Preprocessing, Remote Sensing in India.

Introduction to image interpretation; Basic Principles of Image Interpretation, Elements of Image Interpretation, Techniques of Image Interpretation, Interpretation Keys,

Introduction to digital image processing: Digital Image- Image Rectification And Registration- Geometric Correction, Image Enhancement Techniques (only concepts), Image Classification - Unsupervised Classification and Supervised Classification. Digital Photogrammetry - Stereo Images from Satellites - Data Merging .

Geographic Information Systems (GIS); Definitions and related technology, GIS Operations, GIS Elements, GIS Concepts and Practice, Map projection and Coordinate system.

Vector Data Model: Introduction, Vector Data Representation, Geometric Objects, Topology.
Vector Data Analysis: Introduction, Buffering, Applications of Buffering, Map Overlay, Feature Type and Map Overlay, Map Overlay Methods, Slivers, Error Propagation in Map , Overlay, Distance Measurement, Map Manipulation,

Raster Data Analysis: Introduction, Analysis Environment, Local Operations, Local Operations with a Single Grid, Local Operations with Multiple Grids, Neighborhood Operations, Zonal Operations.

Terrain Mapping And Analysis: Introduction, Data for Terrain Mapping and Analysis, Surface models-DEM, TIN.

GIS Models And Modeling: Introduction, GIS Modeling, Binary Models, Index Models

Remote Sensing & GIS Application In Water Resources Engineering: GIS approach water resources system – Thematic maps - Rainfall-runoff modelling – Groundwater modeling – Flood inundation mapping and Modelling – Drought monitoring – Site selection for artificial recharge - Reservoir sedimentation.

Text books :
1.   Fundamentals of Remote Sensing 2nd Ed – George Joseph, University Press, New Delhi.
2.   Introduction to Geographic Information systems – Kang tsung chang, Tata Mc.G.H. publications, New Delhi.
3.   Lillesand, T.M. and Kieffer, Remote sensing and image interpretation, Joh Wiley and Sons, New York, 1987.
Reference books:
1.   Remote Sensing of the Environment – An earth resource prespective – John R. Jensen, Pearson Education, New Delhi.
2.   Aronoff, S. 1989. Geographic information Systems: A Management Perspective. Ottawa: WDL publications.
3.   Bonham – Carter, G,F. 1994. Geographic Information Systems for Geoscientists: Modeling with GIS. New York: Pergamon Press.
4.   Burrough, P.A and R.A. McDonnell. 1998. Principles of Geographical Information
5.   Systems. Oxford: Oxford University Press.
6.   Lo, C.P., and Albert K.W. Young concepts and Technologies of Geographic Information Systems, Prentice hall of India (Pvt) Ltd, New Delhi.
7.   John R Jensen : Introductory Digital Image processing , Prentice Hall, New Jersey.
8.   Farsworth, R.K., Bawetl, E.C. & Dhanju, M.S., Application of remote sensing to hydrology
9.   including groundwater, IHP, UNESCO, 1984.

WRE 1.5 (a) IRRIGATION WATER SYSTEMS AND MANAGEMENT

Irrigation systems – Major, mini, minor potential surface, lift and GW systems, methods of irrigation, relative merits and demerits, modeling

Soil physics and Soil chemistry; terminology; Soil-water and hydraulic conductivity. Soil chemical properties- impact of soil and water chemical concentrations on yields –management of soil chemical concentrations.
Soil physics and Soil Agriculture, cropping pattern, irrigation, sustainable systems

Planning irrigation systems – crop water requirements, irrigation frequency, yield – Methods of estimation of crop water requirements – methods based on temperature and pan evaporation; combined method; crop coefficient curves.

Surface system design: definitions –furrow system design – level basin system design –graded border system design

Sprinkler System Design: Uniformity and adequacy of water application-evaporation and wind drift- components of system design. Distribution system design and layout- centre pivot system, linear move system- Big gun and Boom sprinkler systems.

Trickle (Drip) irrigation system design: Concept of trickle system- Emitters – flow through laterals – filtration and water treatment systems- fertilizer injection systems.

Water logging and prevention and efficiencies. Optimization techniques in planning as applied to Irrigation.

Agricultural hydrology, subsurface, unsaturated flow, hysterisis, soil moisture and deep percolation, return flows and modeling droughts and mitigation of droughts.

Text Books:
1.   Chaturvedi,Water Resources Systems Planning and Management , M.C. Tata McGraw Hill
2.   James L.D and Lee R.R, Economics of Water Resources Planning, McGraw Hill
3.   Maiche,l Irrigation theory & Practise
4.   Richard H. Cuenea, Irrigation System Design (An engineering approach), Prentice Hall
5.   Deniel P. Louchs, Jerry R. Stedinger and Danglass. A. Haith, Water resources systems planning and analysis , Prentice Hall

Reference books:
1.   Irstelsen and Hanesn, Irrigation – Principles and methods
2.   Mays L.W. and Tung Y.K.,Hydrosystems Engineering and Management McGraw Hill,
3.   Ossenburgen P.J., Systems analysis for Civil Engineer, John Wiley and Sons, Publication of NW, Roorkee

WRE 1.5 (b)   CLIMATE CHANGE AND WATRE RESOURCES

Definitions- Climate, Climate system, climate change – Drivers of Climate change – Characteristics of climate system components - Green house effect – Carbon cycle – Wind systems - Trade Winds and the Hadley Cell – Ozone hole in the stratosphere - El Nino, La Nina

Global Scenario – Indian Scenario – Observed changes and projected changes of IPCC - Impacts on water resources – NATCOM Report –Impacts on sectoral vulnerabilities – SRES – Different scenarios

Need for vulnerability assessment – Steps for assessment –Approaches for assessment – Models – Quantitative models, Economic model, Impact matrix approach - Box models - Zero-dimensional models - Radioactive-convective models - Higher-dimension models - EMICs (Earth-system models of intermediate complexity) - GCMs (global climate models or general circulation models) – Sectoral models

Water-related adaptation to climate change in the fields of Ecosystems and biodiversity, - Agriculture and food security, land use and forestry, Human health, water supply and sanitation, infrastructure and Economy (insurance, tourism, industry and transportation) - Adaptation, vulnerability and sustainable development Sector-specific mitigation - Carbon dioxide capture and storage (CCS) , Bio-energy crops, Biomass electricity, Hydropower, Geothermal energy, Energy use in buildings, Land-use change and management, Cropland management, Afforestation and Reforestation - Potential water resource conflicts between adaptation and mitigation - Implications for policy and sustainable development.

CASE STUDIES: Water resources assessment case studies – Ganga Damodar Project , Himalayan glacier studies, Ganga valley project - Adaptation strategies in Assessment of water resources- Hydrological design practices and dam safety- Operation policies for water resources projects - Flood management strategies - Drought management strategies - Temporal & spatial assessment of water for Irrigation -Land use & cropping pattern - Coastal zone management strategies.

References
1.   IPCC Report Technical Paper VI – "Climate change and water" , 2008.
2.   "UNFCC Technologies for Adaptation to climate change, 2006.
3.   P R Shukla, Subobh K Sarma, NH Ravindranath, Amit Garg and Sumana Bhattacharya, Climate Change and India: Vulnerability assessment and adaptation, University Press (India) Pvt Ltd, Hyderabad.
4.   Preliminary consolidated Report on Effect of climate change on Water Resources, GOI, CWC, MOWR, 2008.

WRE 1.5 (c) ENVIRONMENTAL HYDRAULICS

Hydrology: Statistical analysis of Hydrological Data -, Intensity–Duration frequency Curves. Hydraulics of groundwater flow: Non–equilibrium flow, Yield estimations, Interferences Infiltration galleries, ground water recharge

Transportation and distribution of water: Storage capacity, Pumping of Water, Design and selection of economical diameter of pumping main. Distribution of Water - Pressure and capacity requirements of distribution system, Analysis of networks, Appurtenances in a distribution layout, detection and prevention of leakage mains.

Hydraulics of Sewers: Design of sewers in full and partial flow conditions, Flow at Sewer transitions, Sewage pumping. Open channel flow–design of open channel flow sections.

Transport phenomenon – diffusion – dispersion – advection – adsorption - conservative and non-conservative pollutants. Governing Equations for flow and transport in surface and subsurface waters-chemical and biological process models-simplified models for lakes, streams, and estuaries.

Modelling of the transport phenomenon: complexity - coupled and uncoupled models – linear and nonlinear models - Solution techniques – calibration. Numerical models: FDM, FEM and Finite volume techniques - explicit vs. implicit methods - numerical errors. Different types of Stream quality modeling and Groundwater transport modeling.

References :
1.   Water and waste water Engineering by Fair Gayer and Okun
2.   Engineering Hydrology by K. Subramanya, Tata McGraw-Hill Education
3.   Hydrodynamics of transport for water quality modeling by Martin, L.J. and McCucheon, S.C, Lewis Publishers.
4.   Groundwater by Freeze, R.A. and Cherry. J.A. Prentice Hall,
5.   Groundwater Hydrology by Todd, Wiley Publications

WRE 1.6(a) WATER POWER ENGINEERING

Introduction – types of power development – classification. planning – environmental considerations - data requirement for assessment of hydropower. components of hydropower.

Hydropower installation components – intake structure – water conductor systems – tunnels – surge tanks – penstocks – valves – anchor blocks.

Design principles of surge tanks

Design principles of penstocks and anchor blocks

Types of power house underground – semi-underground. turbines and their foundations – structural and geotechnical aspects of power house design.

References:
1.   Dandekar, M.M. and Sharma, K.N. Water Power Engineering Vikas Publishing House, New Delhi 1994.
2.   Varshney, R.S. Hydro Power Structures – Nem Chand Bros. Roorkee 1973 Guthrie, Brown J. (ed) Hydro Electric Engineering Practice Blackie and Son, Glasgow 1970.

WRE 1.6(b) STATISTICAL METHODS FOR ENGINEERS

Estimation Theory: Estimators: Unbiasedness, Consistency, Efficiency and Sufficiency – Maximum Likelihood Estimation – Method of moments.

Testing Of Hypothesis: Tests based on Normal, t, X2 and F distributions for testing of means, variance and proportions – Analysis of r x c tables – Goodness of fit.

Correlation And Regression: Multiple and Partial Correlation – Method of Least Squares – Plane of Regression – Properties of Residuals – Coefficient of multiple correlation – Coefficient of partial correlation – Multiple correlation with total and partial correlations – Regression and Partial correlations in terms of lower order co-efficient.

Design Of Experiments Analysis of variance – One-way and two-way classifications – Completely randomized design – Randomized block design – Latin square design.

Multivariate Analysis Random vectors and Matrices – Mean vectors and Covariance matrices – Multivariate Normal density and its properties – Principal components: Population principal components – Principal components from standardized variables.

References:
1. Gupta.S.C., and Kapoor, V.K., "Fundamentals of Mathematical Statistics", Sultan Chand and Sons, Eleventh Edition, 2002
2. J.E. Freund, "Mathematical Statistical", 5th Edition, Prentice Hall of India, 2001.
3. Jay L.Devore, "Probability and statistics for Engineering and the Sciences", 5th Edition, Thomson and Duxbury, Singapore, 2002
4. Murray.R. SpiegelandLarry J.Stephens, "Schaum sou Tlines- Statistics", Third Edition, Tata McGraw-Hill, 2000
5. R.A.Johnson and C.B.Gupta, "Miller & Freund s Probability and Statistics for Engineers", Pearson Education, Asia, 7th Edition, 2007
6. Richard A.Johnson and Dean W.Wichern, "Applied Multivariate Statistical Analysis", Pearson Education, Asia, 6th Edition, 2007

WRE 1.6 (c)   WATER QUALITY

Physical and chemical properties of water – Suspended and dissolved solids – EC and pH – major ions –. Water quality investigation – Sampling design - Samplers and automatic samplers - Data collection platforms – Field kits – Water quality data storage, analysis and inference – Software packages

Water quality for irrigation – Salinity and permeability problem – Root zone salinity - Irrigation practices for poor quality water – Saline water irrigation – Future strategies

Sources and Types of pollution – Organic and inorganic pollutants - BOD – DO relationships – impacts on water resources – NPS pollution and its control – Eutrophication control - Water treatment technologies - Constructed wetland.

Multiple uses of water – Reuse of water in agriculture – Low cost waste water treatment technologies - Economic and social dimensions - Packaged treatment units – Reverse osmosis and desalination in water reclamation.

Water quality modeling concept, Process and Classification; Groundwater quality modeling, Surface water quality modeling.

Water quality management, principles of water quality – Water quality classification – Water quality standards - Water quality indices – TMDL Concepts – Water quality models.

References:
1.   George Tchobanoglous, Franklin Louis Burton, Metcalf & Eddy, H. David Stense, "Wastewater Engineering: Treatment and Reuse", McGraw-Hill, 2002.
2.   Vladimir Novonty, "Water Quality: Diffuse pollution and watershed Management", 2nd edition, John Wiley & Sons, , 2003
3.   Mackenzie L Davis, David A Cornwell, "Introduction to Environmental Engineering", McGraw-Hill 2006.
4.   Stum, M and Morgan, A., "Aquatic Chemistry", Plenum Publishing company, USA,
5.   Lloyd, J.W. and Heathcote, J.A., "Natural inorganic chemistry" in relation to groundwater resources, Oxford University Press, Oxford, 1988.

WRE 1.7 COMPUTATIONAL FLUID MECHANICS LABORATORY

Developing and executing programmes using C-language for the following problems related to fluid mechanics:
1.   Pipe network analysis using Hardy- Cross method..
2.   Pipe friction computations.
3.   Gradually varied flow problems.
4.   Hydraulic jump computations.
5.   Unit hydrograph computations.
6.   Flood routing. (Muskingum method)
7.   Water Hammer Analysis

WRE 1.8   G.I.S. LABORATORY

Students are supposed to work on various problems involving the following applications using any GIS package.

1. Creation of vector maps and raster maps through digitization and rasterisation
2. Image Processing of digital images (geometric correction, image enhancement, image classification)
3. Preparation of thematic maps (Land use/ land cover, road maps, drainage network map etc.) from satellite image of any region.
4. Watershed delineation from drainage map and contour map of any region.
5. Development of Digital Elevation Model (DEM) using any technique.

II – SEMESTER

WRE 2.1 WATERSHED MANAGEMENT

Watershed Management Concept: Introduction, Concept of Watershed Management, History of Watershed Management and its Relevance to India, Watershed Characteristics; Climatic Characteristics, Physiographic Characteristics, Causes of Watershed Deterioration, Effect of Watershed on the Community, Water Resources Region of India

Principles Of Watershed Management: Integrated Watershed Management Approach (IWMA); Objectives of IWMA, Envisaged Results, Success Criteria, Selection of Watershed Village, Equity Issues for Watershed Policies, Factors Causing the Inequality, Benchmark Survey, Remote Sensing Survey in Watershed Management, Land Capability Classification.

SOIL EROSION: Introduction, Soil Erosion, Factors Affecting Soil Erosion, Different Types and Causes of Erosion- Geologic Erosion, Accelerated Erosion, Estimation of Loss of Soil from Erosion, Soil Loss Models, Sediment Models, Bed Load Models, Control of Soil Erosion*49*

Management Of Natural Drainages: Introduction, Check Dam, Structures for Gully Stabilization and Storage of Water, Rivers or Stream Bank Management Measures in Watershed, River Training Works, Methods of River Training Works

Wasteland And Land Drainage Management: Introduction, Causes of Wasteland – Water logging, Salinity, Soil Erosion, Overgrazing, Mining Operation, Industrial Effluent, Brickfields, Inadequate Surface and Subsurface Drainages, Remedial Measures in Wasteland Management, Land Drainage Management- Surface or Overland Drains, Subsurface or Underground Drains, Discharge and Spacing of Tile Drain.

Flood Damage Mitigation Management: Introduction, Mitigation Measures, Structural Mitigation Measures, Non-Structural Mitigation Measures, Flood Plain Zoning, Flood Forecasting.

Water Harvesting: Introduction, Techniques of Water Harvesting, Indigenous Water Harvesting Methods in India, Engineering Methods of Water Harvesting.

Watershed Modelling: Introduction, Data of Watershed for Modeling, Application of Watershed Models, Model Calibration and Validation

Text book:
1. Madan Mohan Das, Mimi Das Saikia, "Watershed Management", PHI Learning Pvt. Ltd., 30-Oct-2012
2. Murty, J.V.S., Watershed Management, New Age Intl., New Delhi 1998.
3. Allam, G.I.Y., Decision Support System for Integrated Watershed Management, Colorado State University, 1994.

4. Vir Singh, R., Watershed Planning and Management, Yash Publishing House, Bikaner, 2000.
5. American Society of Civil Engineers, Watershed Management, American Soc. of Civil Engineers, New York, 1975.

WRE 2.2   HYDRAULIC STRUCTURES & MATERIALS

Design Principles of Storage Works: Recapitulation of Planning, Analysis and Design of Gravity Dams; Design of Non overflow and overflow sections based on multiple step method, Design principles and construction practices of Earthen dams.

Recapitulation of Design principles of weirs on permeable foundations, Regulators -Functions of Regulators, Head Regulators and Cross Regulators-Hydraulic Design of Regulators.
Cross Drainage Works- Types of C.D.Works and choice of the type, Design of C.D.Works.

Hydropower Structures: A)Intake Structures, (B) Trash Racks, (C) Penstocks (D) Surge Tanks
Miscellaneous Hydraulic structures: A) Water supply works, (B) Infiltration Wells, (C) Clarifloculator and (D) R.C.C. Water storage tanks and sumps.

Materials: Cements, Aggregates, Admixtures and Chemicals, Fresh Concretes, Hardened Concrete; Special Concretes

Strength of Concrete, Concrete Mix Design.

 Geotextiles and Fibre reinforced plastics.

Text Books:
1.   B.C. Punmia, Irrigation & Water power Engg..
2.   S.K. Garg..Irrigation Engg & Hydraulic Structures
3.   Varshney, Hydro Power Structures.
4.   by I.C. Syal and R.K. Ummat., Behaviour, Analysis and Design of Structural Elements.
5.   M.S. Chetty, Concrete Technology Theory and Practice.
Reference Books:
1.   P. Dayaratnam , Design of Reinforced Concrete Structures
2.   S. Ramamrutham, Design of Reinforced Concrete Structures .

WRE 2.3 URBAN STORM WATER DRAINAGE

Introduction to drainage problems in different climates: Urbanisation, its effects and consequences for drainage-interaction between urban and peri-urban areas Process of urbanisation and influence on hydrologic cycle
Planning concepts and system planning: Objectives of urban drainage and planning criteria, drainage and system layout. Planning tools and data requirement, drainage master plan, examples for drainage structures.

Review of Hydrologic and hydraulic principles: Urban hydrologic cycle, hydrologic principles, Rainfall analysis in Urban environment and design storm, hydraulic principles, hydrodynamic principles.

Urban Runoff computations : Empirical, Time-area and unit hydrograph approaches

Design of drainage system elements: Hydraulic fundamentals, infiltration and on-site detention of stormwater, design of sewerage and drainage channels, design of appurtenances, road drainage, design of pumping stations.

Control of stormwater pollution: Pollution build-up and washoff process with reference to urban drainage systems. Source control in commercial and industrial complexes, storage options - dry and wet ponds, biological treatment of wastewater, chemical treatment of stormwater.

Operation and maintenance of urban drainage systems: Maintenance requirement for different structures, maintenance planning, cleaning of sewers and drains, inventory of damages, repair options.

Urban drainage : Kinematic wave theory approach

Introduction to urban watershed softwares Hydrologic Cistern, water conservation and ecological aspects Water harvesting

Text-Books:
1.   Chow, V.T., Handbook of Applied Hydrology : A Compendium of Water resources
2.   Gupta, R.S., Hydrology and hydraulic systems, Prentice Hall, Englewood cliffs,
3.   Urban Hydrology : Hall, M.J.
4.   Hydrology : Viesmann & Knapp

WRE 2.4   ENVIRONMENTAL IMPACT ASSESSMENT OF WATER RESOURCES PROJECTS

Water resources development and environmental issues – Environment in water resources project planning – Impact types: beneficial & adverse, primary, secondary, long-term, short-term, reversible and irreversible.

Procedural requirement for EIA and clearance - Indian Scenario

Hydrological and water quality impacts – Ecological and biological impacts – Social and cultural impacts – Soil and landscape changes – Agro economic issues – Human health impacts – Ecosystem changes.

EIA team formation – Development of scope, mandate and study design – Base line survey – Check lists – Ad hoc procedures – Network and matrix methods – Semi-quantitative methods – ICID checklist – Economic approaches – Environmental Impact Statement (EIS) preparation. 28 In-stream ecological water requirements - Public participation in environmental decision making – Sustainable water resources development – Ecorestoration – Hydrology and global climate change – Human ecology – Ecosystem services – Environmental monitoring programs.

Text Books :
1. Biswas, A.K. and Aggrawal, S.B.C., Environmental Impact Assessment for Developing
2. Countries.
3. Canter, L., Environmental Impact of Water Resources Projects.
4. Munn, R.E., Environmental Impact Assessment; Principle and Procedure.
5. Ray, S.G. & Wooten, D.C., Environmental Impact Analysis Handbook.
6. Saxena, K.D., Environmental planning, policies & programmes in India, Shipra Publishers,
References
1. 1 Patrick Mc Cully; Silenced Rivers ,Orient Longman Publications.
2. Barathwal, R.R., Environmental Impact Assessment. New Age International Publishers, New Delhi. 2002.
3. Petts, J., Handbook of Environmental Impact Assessment, Vol., I and II, Blackwell Science London. 1999.
4. Lawrence, D.P., Environmental Impact Assessment – Practical solutions to recurrent problems, Wiley-Inter Science, New Jersey. 2003.
5. Arnel, N., Hydrology and global environmental change. Prentice Hall, Harlow. 2002.
6. UNEP's Environmental Impact Assessment Training Resource Manual -2nd Edition, 2002.

WRE 2.5 (a) WATER RESOURCES PROJECT MANAGEMENT

Planning & Management of Water Resources Projects : Introduction to the fundamentals of water resource system analysis, involving the determination of the optimal dimensions, outputs and operating policies of water resource projects.

Introduction ; Reservoir Capacity & Yield ; Flow-Duration Curve ; Reservoir Planning
Reservoir Sediment Distribution ; Cost Benefit Analysis ; Conjunctive Water-Use Planning

Flood Routing ; Reservoir Operation ; River Water Disputes ;

Integrated River-Basin Development ; Inter-Basin River Water, Transfers ; Environmental Aspects

Overview of methodologies of analysis. Use of optimisation and simulation techniques for solving water resources problems. Examples in water distribution systems, flood management, river basin planning for irrigation and hydroelectric power. The storage yield relationship.

Engineering Economics : Objectives & scope of Engineering Economics, Managerial Economics, Interest and time-value of money, Depreciation, Economic life.

Demand analysis and forecasting. Cost concept, Annual cost comparison, Present worth, Production Functions, Pricing policies, pricing methods, price forecasting.
Profit, measurement of profit, profit planning & forecasting, Break-even analysis, Return on investment, Rate of return. ; Mathematics of Finance ; Discounting Techniques ; Estimation of Costs

Estimation of Benefits ; Graphical Optimization ; Systems Approach

Multi Objective Analysis ; Financial Analysis ; Cost Allocation ; Case Studies
Capital budgeting, cost of capital, project appraisal.

Text books & reference books:
1.   1.Goodman, A.S., Principles of Water Resources Planning, Prentice Hall Inc., New Jercy,
2.   James, L.D. and Lee, R.R., Economics of Water Resources Planning, Mc Graw Hill,
3.   Warnic, C.C., Hydropower Engineering, Prentice Hall Inc., New Jercy, 1984.
4.   Goodman, A.S., Principles of Water Resources Planning, Prentice Hall Inc., New Jercy,
5.   James, L.D. and Lee, R.R., Economics of Water Resources Planning, Mc Graw Hill, Inc.,
6.   Chaturvedi, Water Resources Systems, Planning & Development :
7.   Hall & Dracup, Water Resources Systems
8.   Barish N. Norman, Economic Analysis.
9.   Varshney, R.L. & Maheshwari, K.L., Managerial Economics.

2.5 (b) WATER RESOURCE SYSTEMS ANALYSIS

System Concepts: Definition, classification, and characteristics of systems - Scope and steps in systems engineering - Need for systems approach to water resources and irrigation.

Linear Programming: Introduction to operations research - Linear programming, problem formulation, graphical solution, solution by simplex method - Sensitivity analysis, application to design and operation of reservoir, single and multipurpose development plans - Case studies.

Dynamic Programming: Bellman's optimality criteria, problem formulation and solutions - Application to design and operation of reservoirs, Single and multipurpose reservoir development plans - Case studies.

Simulation: Basic principles and concepts - Random variant and random process - Monte Carlo techniques - Model development - Inputs and outputs - Single and multipurpose reservoir simulation models - Case studies.

Advanced Optimization Techniques: Integer and parametric linear programming - Goal programming models with applications Discrete differential dynamic programming and incremental dynamic programming - Linear decision rule models with application - Stochastic dynamic programming models.

References:
1. Daniel P. Loucks and Eelco van Beek, "Water Resources Systems Planning and Management- An Introduction to Methods, Models and Applications", United Nations Educational, Scientific and Cultural Organization, 7, place de Fontenoy F-75352 Paris 07 SP, 2005.
2. Gupta P.K and Man Mohan, "Problems in Operations Research (Methods and solutions)". Sultan Chand and sons, New Delhi, 1995.
3. Hiller F.S and Liebermann G.J., "Operations Research" CBS Publications and distributions. New Delhi, 1992.
4. Chaturvedi. M.C., "Water Resources Systems Planning and Management". Tata McGraw Hill, New Delhi, 1997.
5. Mays L.W., and Tung YK, "Hydro systems Engineering and Management". McGraw Hill Inc., New York, 1992.

WRE 2.5 (c) FINITE ELEMENT METHODS OF ANALYSIS

Introduction: A brief history of F.E.M. Need of the method, Review of basic principles of solid mechanics- Equations of equilibrium, Boundary conditions, Compatibility, Strain displacement relations, Constitutive relationship in matrix form, plane stress & plane strain and axisymmetric bodies of revolution with axi-symmetric loading, Energy principles - Raleigh - Ritz method of functional approximation.

Theory relating to the formulation of the finite element method, Coordinate system (local and global), generalized coordinates, Concept of the element, Various element shapes, Discretisation of a structure, Mesh refinement Vs. Higher order element, Interconnections at nodes of displacement models, inter element compatibility, -shape functions.

Basic component – One dimensional FEM single bar element, Beam element : Derivation of stiffness matrix, Assembly of stiffness, Matrix boundary conditions, shape functions for 1 D elements, Initial strain and temperature effects, and trusses under axial forces.

Two dimensional FEM**:** Different types of elements for plane stress and plane strain analysis – Displacement models Generation of element stiffness and nodal load matrices –static condensation.

Isoperimetric representation and its formulation for 2d analysis. Formulation of 4-noded and 8-noded isoparametric quadrilateral elements – Lagrangian elements-serendipity elements.

References :
1.   Introduction to Finite element Method by Tirupathi chandra Patla and Belugundu
2.   C.S.Krishnamoorthy, (2002), Finite Element Analysis, Tata McGraw Hill Publishing Co.
3.   The Finite Element Method in Engineering Science" by Zienkiewicz, P., McGraw Hill,
4.   Introduction to Finite Element Method by Desai,C.S.and Abel, J.F.,Van Nostrand, 1972.

WRE 2.6 (a) ESTUARINE HYDRAULICS

Introduction to estuaries in general, Morphological and geological features. Salinity gradients, Tide propagation and associated currents.
 Estuaries classifications, Estuarine residual circulation theories and application.
 Sediment processes (turbidity maximum and fluid mud).
Long-term morphodynamic evolution, Physical processes and management.
Case studies (from literature).
Text books:
1.   Estuary and coastline hydrodynamics / Arthur T. Ippen [editor]., New York : McGraw-Hill Book Co.

WRE 2.6 (b) SUB-STRUCTURE DESIGN

Substructure Design: Introduction, Substructure – Definition and purpose, Role of foundation engineers, General requirements of substructure, Scope.

Ground Improvement Techniques: Introduction, Soil stabilization, Sand pile accept, Stone columns, Reinforced earth – Introduction, Basic mechanisms of reinforced earth, Choice of soil, Reinforcement, Strength characteristics of reinforced soil, Reinforced earth retaining walls and reinforced earth slab.

Marine Substructures: Introduction, Type of marine structures – Break waters, Wharves, Piers, Seawalls, Docks, Quay walls, Locks and moorings, Design loads, Combined loads, Wave action, Wave pressure on vertical walls, Ship impact on piled wharf structures, Design of breakwaters, Rouble-Mound break waters, Wall type break water, Gravity wall and anchored bulk head wharf structures, Design of piled wharf structures.

Sheet Piles: Introduction, Type of sheet pile structures, Design of cantilever sheet piling wall, Design of anchored bulkheads, Anchorage methods, Design of braced sheeting in cuts, Design of cellular cofferdams.

Foundations in Expansive Solis: Introduction, Mineral structure, Identification of expansive soils, Swell potential and swelling pressure, Traditional Indian practice, Methods of foundations in expansive soils, Replacement of soils and 'CNS' concept under reamed pile foundation, Remedial measure for cracked buildings.

Foundations of Transmission Line Towers: Introduction, Necessary information, Forces on tower foundations, General design criteria, Choice and type of foundation, Design procedure.

Machine Foundations: Types of foundations, Design criteria, IS code previsions, Construction details of machine foundations vibration isolation.

References
2. "Analysis and Design of Substructures Limit State Design" by Swami Saran, Oxford and IBH Publishing Co. Pvt. Ltd., New Delhi.
3. **"**Dynamics of Bases and Foundations" by Barken**.**McGraw Hill Company

WRE 2.6 (c) FLOOD MODELLING AND DROUGHT ASSESSMENT

Flood Estmation **:** Hydrologic extremes – Flood – Types of Flood – Effects of Flood – Design Flood - SPF/MPF - Estimation of design flood – Physical Indicators - Envelope curves - Empirical methods – Rational method - Statistical methods – Frequency analysis – Unit hydrograph method.

Flood Modelling And Management **:** Hydrologic and Hydraulic Routing – Reservoir and Channel Routing - Flood Inundation Modelling – HEC HMS and HEC RAS softwares - Flood control methods – Structural and non structural measures - Flood Plain Zoning – Flood forecasting – Flood Mitigation - Remote Sensing and GIS for Flood modelling and management.

Drought And Impacts : Definition – Definitions based on rainfall, stream flow, vegetation and comprehensive aspects - Characterization of Drought/water shortage/aridity/desertification - Types of Drought – NCA classification – Impacts of Drought – Environmental, Social and Economical aspects

Drought Assessment: Drought Severity Assessment – Meteorological Hydrological and Agricultural methods – Drought Indices – GIS based Drought Information system – Drought Vulnerability Assessment and Mapping Using GIS.

Drought Monitoring And Management: DPAP Programme - Drought Monitoring – Application of Remote sensing – Drought Mitigation –Proactive and Reactive Approach – Supply and Demand Oriented Measures – Long term and Short term Measures – Water Scarcity Management in Urban, Industrial and Agricultural sectors

References:
1. Chow V.T., Maidment D.R., Mays L.W., "Applied Hydrology", McGraw Hill Publications, New York, 1995.
2. Vijay P.Singh., "Elementary Hydrology", Prentice Hall of India, New Delhi, 1994.
3. Yevjevich V., "Drought Research Needs", Water Resources Publications, Colorado State University, USA, 1977.
4. Rangapathy V., Karmegam M., and Sakthivadivel R., Monograph in "Flood Routing Methods as Applied to Indian Rivers", Anna University Publications

WRE 2.7   HYDRAULICS LABORATORY

1. Hydraulic Jump in horizontal and rectangular channels.
2. Gradually Varied Flow Profiles.
3. Studies on Groundwater flow and Well hydraulics.
4. Flow past Bluff bodies, Airfoil and Cylinder.
5. Open channel discharge measurement.

WRE 2.8   SEMINAR

Each student has to select a topic and collect about 10 papers with at least 5 journal papers and prepare a report and give a seminar at the end of the semester

Department Of Civil Engineering
M TECH. (TRANSPORTATION ENGINEERING)
Scheme of Instruction and Examination
(with effect from 2015-16 academic year)

I – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
TE1.1	Urban Transportation Planning	4	--	4	3	70	30	100	4
TE1.2	Traffic Engineering and Management	4	--	4	3	70	30	100	4
TE1.3	Geometric Design of Highways	4	--	4	3	70	30	100	4
TE1.4	Analysis and Design of Pavements	4	--	4	3	70	30	100	4
TE1.5	a)Advanced foundation Engineering b)Pavement Management Systems c)Highway Construction Practice	4	--	4	3	70	30	100	4
TE1.6	a)Operations Research b)Bridge Engineering c)Project Planning and Management	4	--	4	3	70	30	100	4
TE1.7	Computational Transportation Engineering Laboratory	--	3	3	Viva	50	50	100	2
TE1.8	Traffic Engineering Laboratory		3	3	Viva	50	50	100	2
Total		**24**	**6**	**30**		**520**	**280**	**800**	**28**

II – SEMESTER

Code No.	Course title	Scheme of Instruction			Scheme of Examination			Total	Credits
		Lec	Tut	Total	Exam (hrs)	Ext	Sess		
TE2.1	Traffic flow theory	4	--	4	3	70	30	100	4
TE2.2	Transportation Economics and Project Appraisal	4	--	4	3	70	30	100	4
TE2.3	Airport Planning and Design	4	--	4	3	70	30	100	4
TE2.4	Analysis of Transportation Systems	4	--	4	3	70	30	100	4
TE2.5	a) Probability and Statistics b) Pavement Materials c) Finite Element Methods of Analysis	4	--	4	3	70	30	100	4
TE2.6	a) Ground Improvement Techniques b) GIS Applications in Transportation Engineering c) Environmental Impact Assessment and Auditing	4	--	4	3	70	30	100	4
TE2.7	Pavement Material and Evaluation laboratory	--	3	3	Viva	50	50	100	2
TE2.8	Design Project		3	3	Viva	50	50	100	2
Total		**24**	**6**	**30**		**520**	**280**	**800**	**28**

III and IV SEMESTERS

Code No	Course title	Scheme of Examination	Total Marks	Credits
TE3.1	Dissertation (Preliminary)	Viva-voce	**100**	**10**
TE4.1	Dissertation (Final)	Defence and Viva-voce	**100**	**14**

Department Of Civil Engineering
M TECH. (TRANSPORTATION ENGINEERING)
Syllabus
(with effect from 2015-16 academic year)

I – SEMESTER

TE 1.1 - URBAN TRANSPORTATION PLANNING

Travel Demand Concept: Demand function: Independent variables: Travel attributes; Assumptions in Travel demand estimation; Sequential, Sequential recursive and Simultaneous process.

Data Collection And Inventories: Study area definition; Zoning principles; Travel data collection - Road side interview, Home
interview; IPT surveys; Sampling techniques; Expansion factors; Use of Secondary sources in data collection.

Travel Demand Estimation: Four step Travel Demand Forecasting approach; Trip generation Analysis; Zonal models Category analysis; Household models; Trip attraction of work centres.

Trip Distribution: Mode Factor methods; Gravity model; opportunity model.

Mode Split Analysis: Mode choice behaviour; Comp~ting modes; Diversion curves; Probabilistic approaches.

Traffic Assignment: Traffic network and coding; Minimum path trees; All or nothing assignment; Capacity restraint assignment;Corridor Identification; Plan preparation and Evaluation; Deficienc analysis.

References:
1. Introduction to Transportation Planning - M.J.Bruton; Hutchinson cf London Ltd.
2. Introduction to Urban System Planning - B.G.Hutchinson; Mc Gra Hill.
3. Urban Transportation Planning Guide - Roads & Transportation AS~C(i<:tion of Canada; University of Toronto Press.
4. Traffic Engineering and Transport Planning - Kadiyali L.R. Khanna Publis
5. Lecture notes on UTP - Prof. S.Raghavachari, R.E.C. Warangal

TE 1.2 - TRAFFIC ENGINEERING AND MANAGEMENT

Traffic Characteristics: Basic traffic characteristics - Speed, volume and concentration. Relationship between Flow, Speed and Concentration

Traffic Measurement And Analysis: Volume Studies - Objectives, Methods; Speed studies - Objectives: Definition of Spot Speed, time mean speed and space mean speed; Methods of conducting speed studies;

Speed Studies: Methods of conducting speed studies; Presentation of speed study data; Head ways and Gaps; Critical Gap; Gap acceptance studies.

Highway Capacity And Level Of Service: Basic definitions related to capacity; Level of service concept; Factors affecting capacity and level of service; Computation of capacity and level of service for two lane highways Multilane highways and free ways.

Parking Studies And Analysis: Types of parking facilities - on street parking and off street Parking facilities; Parking studies and analysis.

Traffic Safety: Accident studies and analysis; Causes of accidents - The Road, The vehicle, The road user and the Environment; Engineering, Enforcement and Education measures for the prevention of accidents.

Traffic Control And Regulation: Traffic Signals - Design of Isolated Traffic Signal by Webster method, Warrants for signalisation, Signal Co-ordination methods, Simultaneous, Alternate, Simple progressic and Flexible progression Systems.

Traffic And Environment: Detrimental effects of Traffic on Environment; Air pollution; Noise Pollution; Measures to curtail environmental degradation due to traffic.

References:
1. Traffic Engineering and Transportation Planning - L.R. Kadiyali, Khanna Publishers.
2. Traffic Engineering - Theory & Practice - Louis J. Pignataro, Prentice Hall Publication.
3. Principles of Highways Engineering and Traffic Analysis - Fred Mannering & Walter P. Kilareski, John Wiley & 50ns Publication.
4. Transportation Engineering - An introduction - C. Jotin Khistry, Prentice Hall Publication.
5. Fundamentals of Transportation Engineering - C.S.Papacostas, Prentice Hall India

TE 1.3 - GEOMETRIC DESIGN OF HIGHWAYS

Geometric design provisions for various transportation facilities as per AASHTO, IRC and other guidelines.Discussion of controls governing geometric design, Route layout and selection.

Elements of design – sight distances, horizontal alignment, transition curves, super elevation and side friction.Vertical alignment – grades, crest and sag curves.

Highway cross-sectional elements and their design for rural highways, urban street and hill roads.At–grade intersections, sight distance considerations and principles of design, channelisation, mini round-abouts, layout of round-abouts.

Interchanges – Major and minor interchanges, entrance and exit ramps, acceleration and deceleration lanes, bicycle and pedestrian facility design.

Parking layout and design. Terminal layout and design.

References:
1. AASHTO Design Guide, A Policy on Geometric Design of Highways and Streets, 2001.
2. Fruin, Pedestrian Planning and Design, McGraw Hill Publication, 2003.
3. Institution of Transportation Engineers, Traffic Engineering Hand Book, 4th Edition, Prentice Hall, 1999.
4. Khisty, C. J., and Lall, B. K., Transportation Engineering: An Introduction, Prentice Hall International, Inc., 2002.

TE 1.4 - ANALYSIS AND DESIGN OF PAVEMENTS

Pavement types, stress distribution pavements - theoretical and actual Sub grade conditions and traffic loading. Design principle and methods for flexible and rigid pavements.

Design of heavy duty pavements. Concrete block pavements.

Evaluation of pavement condition, pavement instrumentation: Types of pavement distresses, their origins and remedy.

Roughness and skid resistance. Environmental effects and influences.

Pavement maintenance, overlays. Pavement management systems.

References:
1. Pavement Analysis and Design, second edition, by Yang H. Huang, Prentice Hall publishers.
2. Shell Pavement Design Manual - asphalt pavements and overlays for road traffic, by Nilanjan Sarkar, Ooms Avenhorn Holding India Pvt.Ltd;
3. Highway engineering by Khanna & Justo .

TE 1.5 (a) - ADVANCED FOUNDATION ENGINEERING

Bearing capacity of shallow foundation, applications of bearing capacity theories, methods - Terzaghi, Mayerhoff, Brinch Hanson, Skempton, Balla.
Field methods - standard penetration test, factors effecting N value, Plate load test, Coefficient of Sub grade reaction and its determination.

Settlement analysis - Elastic and consolidation settlement, settlement estimates from penetration test, plate load test, construction period correction.
permissible total and differential settlement, causes of settlement, control of settlement, remedial measures, proportion of footing, contact pressure and active zone from pressure bulb concept. Factors effecting failures of foundation, case studies, and remedial measures.

Pile foundations - selection of pile foundation, load carrying capacity - dynamic formula, static formula, pile load test - pull out test, lateral load test, initial load test, routine load test, cyclic load test. Settlement of pile and pile groups, negative skin friction, laterally loaded piles - **B**room's analysis, IS code method. Under reamed piles, method and design.

Caissons and well foundations - design aspects of caissons, open caissons, pneumatic caissons, floating caissons, well foundations, monoliths, design and construction aspects of well foundations.

References:
1. Foundation analysis and Design by Bowles, Mc.Graw Hill Inc., second edition.
2. Geotechnical Engineering by C. Venkatramayya, New age international publishers. Soil Mechanics and Foundation Engineering, Vol. II, V.N.S. Murthy.

TE -1.5 (b).PAVEMENT CONSTRUCTION AND MANAGEMENT

Pavement Management System: Components of PMS and their Activities, Major Steps in Implementing PMS, Inputs, Design,Construction and Maintenance, Rehabilitation and Feedback Systems, Example~ of HDM and RTIM Packages, Highway Financing, Fund Generation, Evaluating Alternate Strategies and Decision Criteria.

Pavement Inventories And Evaluation**:** Serviceability Concepts, Visual Rating, Pavement Serviceability Index, Roughness Measurements, Distress Modes - Cracking, Rutting etc, Pavement Deflection – Different Methods, Skid Resistance, Roughness, Safety Aspects. Inventory System - Assessment of Deficiencies.

Pavement Maintenance And Quality Control**:** Causes of Deterioration, Traffic and Environmental Factors, Pavement Performance Modelling Approaches and Methods, Methods of Maintaining WBM, Bitumen and Cement ConcreteRoads, Quality Assurance / Quality Control - ISO 9000; Sampling Techniques Tolerances and Controls Related to Profile and Compaction.

Construction Of Base, SubBase, Shoulders And Drain: Roadway and Drain excavation, Excavation and Blasting, Embankment construction, Construction of Gravel, Lime, Cement stabilised sub-bases, WBM Bases, Wet Mix Construction, Crushed Cement Bases, Shoulder Construction Drainage: Surface/Subsurface,Turfing, Sand Drains, Sand Wicks. Rope Drains, Geo-textile Drainage, Preloading Techniques.
 Bituminous Pavement Construction:

Preparation and Laying of Tack Coat, Bituminous Macadam, Penetration Macadam, Built up. Spray Grout, Open Graded Premix, Mix Seal, Semi-dense, Asphalt Concrete ¬Interface Treatments and Overlay Construction, IRC Specifications, Introducing Mechanical Mixers, Pavers, Finishers.

Cemennt Concrete Pavemennt Analysis: Construction of Cement Concrete Roads, Manual and Mechanical Methods, Joints in Concrete and Reinforced Concrete Pavements, Interface Treatment and overlay construction - Related Equipment.

Pavement Life Cycle Cost Analysis: Cost Components, Methods of LCA - Brief Description - Items Considered - Case Studies

Pavement Maintenance Management: Components of Maintenance Management and Related Activities - Network and Project Level Analysis - Budgeting - Prioritisation Techniques and Formulation of Maintenance Strategies.

References:
1. Haas and Hudson, W.R. Pavement Management Systems - McGraw Hill
2. Sargious, M.A. - Pavements and Surfacing for Highways and Airports - Applied Science Publishers Ltd.
3. Bridge and Pavement Maintenance - Transportation Research Record No.BOO, TRB
4. Shahin MY,1994 - Pavement Management for Airports, Roads and parking Lots.
5. Bent Thagesan, 1996 - Highway and Traffic Engineering for Developing Countries.

TE-1.5(c). HIGHWAY CONSTRUCTION PRACTICE

Embankment Construction: Formation cutting in Soil and hard rock, Preparation of Subgrade, Ground improvement, Retaining and Breast walls on hill roads, Granular and Stabilized, Sub - bases / bases, Water Bound Macadam (WBM), Wet Mix Macadam (WMM), Cement treated bases, Dry Lean Concrete (DLC).

Bituminous Constructions: Types of Bituminous Constructions, Interface Treatments, Bituminous Surfacing and wearing Courses for roads and bridge deck slabs, Selection of wearing Course under different Climatic and Traffic conditions, IRC
 specifications, Construction techniques and Quality Control.

Concrete Road Construction: Test on Concrete mixes, Construction equipments, Method of construction of joints in concrete pavements, Quality Control in Construction of Concrete pavements, Construction of Continuously reinforced, Prestressed, Steel Fibre Reinforced (SFRC) Pavements, IRC, MORT&H, ACI Specifications, AASHTO Specifications, Recycled pavements, Non - Conventional Pavements, Overlay Construction.

Hill Roads Construction: Stability of Slopes, Landslides - Causes and Control measures, Construction of Bituminous and Cement Concrete roads at high altitudes, Hill road drainage, Construction and maintenance problems and remedial measures.

References:
1. Highway engineering by S.K khanna, justo,
2. IRC and MORT&H ACI specifications,
3. AASHTOspecifications

TE .1.6(a)   OPERATIONS RESEARCH

Linear programming Introduction& problem formulation.
Graphical solutions - SIMPLEX method
Duality in Linear programming.
Transportation problem
Assignment and routing problem.
Queuing theory.

References:
1.   Operation research by Kanti Swarup, Gupta and Manmohan.
2.   Operation research and statistical analysis by S.D.Sharma
3.   Operations Research by Ranganath, Yes Dee publishing Pvt Ltd

TE1.6(b). BRIDGE ENGINEERING

Introduction - Classification - Investigation for bridges - Loading standards - IRC and Railway loads -Impact

Bridge substructure - Determination of maximum flood discharge - Determination of linear water way

Bridge substructure -Determinations of maximum depth of scour - loads acting on substructure - design of pier and pier cap -design well elements - sinking of wells.

Bridge Superstructure - Pigeaud's curves method for design of slab - Analysis of beams - Courbon's Method - Hendry Jaeger Method - Guyon and Massonet Method

Bridge Superstructure-Box Girder Bridges - Grillage analogy

Cable Bridges - Advantages - Arrangement of ~,tay cables - types of towers - Linear analysis of cables, and towers.

Bridge Bearings and expansion joints - Functions types and selection of bearings - bearing materials

Design of electrometric bearings for different conditions - expansion joints - types of expansion joints.

References:
1. Analysis and design of substructures - Swami Saran - Oxford & IBH Publishing Co., 1996
2. Bearings in structural engineering - J.E. Long - Newnes Butterworth & Co., 1974
3. Bridge bearings and Expansion Joints - D.J. Lee - 2e - E&FN Span, 1994 4. Concrete Bridge Design - Rowe - John Wiley & Sons inc., 1962.
4. The analysis Grid Frameworks and related structures - Hendry & Jaeger - Chatto & Windus,-
5. Bridge analysis by Microcompter - Jaeger & Bakht - rv1c Graw Hill, 1989. '
6. Grillage analogy in bridge deck analysis - C.S Surana & R. Agarwal - Narosa Pub-
7. Method of analysis and design of concrete box beams with side cantilever - Maisel and Roll-
8. Cement and Concrete Associations - 1974
9. Cable stayed bridges - M.S. Troitsky - 2e, Van Nostrand Reinhold Company, 1988

TE1.6(c) . PROJECT PLANNING &MANAGEMENT

Introduction to Project Management: A systems Approach, Systems Theory and Concepts,Organisation, Management Functions, Overview of Management Objectives, Tools and Techniques,Project Management - Processes and organiscitional Structures – Team Management - Project Manager as a Team Leader - Leadership Qualities, PMIS

Construction Cost and Value Engineering" Types of Estimates, ImplementatIon of Cost Controls, Project Cost Forecasting, Cost Optimisation a,ld Resources Planning - Value Eng!Jineering, Techniquesfor Project Selection, Break-Even Analysis, Cost Modelling, Energy Modelling, Life Cycle Cost Approach'.

Contract Management: Tendering and COiltracting, Laws of Contracts, subcontracts,
Potential, Problems, Post Contract Problems, Documents, Conditions, Arbitration, Special Features of International, Contracts.

Quality Management and Safety in Construction Industry: Quality control by statistical methods,sampling lan, control charts, ISO 14000, Safety Measures, Safety Programmes, Safety Awareness andImplementation of Safety Plan – Compensation. Project Scheduling and Analysis Methods: CPM, PERT, Linear programming, queuing concept,simulation, bidcjing models, game theory.

Human Resource Management: Man Power Planning - Training - Motivation - IndustrialRelations ¬Welfare Measures - MIS - Components and Structure - Personal Management.

Resource Management and Inventory: Basic concepts, labour requirements & productivity, nonproductive activities, site productivity, equipment and material management,
inventory control .
Construction Management Practices: Implementation of Procedures and Practices - International Experiences - Case Studies - Examples.

References:
1. Herold Kerzner - Project Management - A systems approach to Planning, Scheduling and Controlling.CBS Publishers and Distributors.
2. K.Waker A Teraih and Jose M.Grevarn; Fundamentals of Construction Management and Organisations.
3. Anghel Patterson - Construction Cost Engineering Handbook - Marcel Dekken Inc.
4. Dell Isola - Value Engineering in Construction Industry, Van Nostrand Reinhold Co.,
5. Choudhary, S. Project Management, Tata McGraw Hill Publishing Co., Ltd.,
6. Raina UK, Construction management Practices, Tata Me G~awhill Publishing Company Ltd.
7. A Guide to the Project Management Body of ~nowledge (PMBOK), Draft Copy, 1994. A Publication of the Project management Institute, USA.
8. Sengupta Band Guha H, Construction Management and Planning, Tata McGraw-Hili Publishing Company Limited, New Delhi

TE 1.7 - COMPUTATIONAL TRANSPORTATION ENGINEERING LABORATORY

1. Programming in C language – functions, arrays, strings, structures, file operations
2. Data structures.
3. Applications in Transportation Engineering.

TE 1.8 - TRAFFIC ENGINEERING LABORATORY

1. Traffic surveys like traffic volume count, speed study, parking study, intersection turning movements, speed & delay study.
2. Moving observer survey.
3. Origin–destination surveys.
4. Road side and house hold interviews.
5. Road lighting.
6. Traffic noise measurement.
7. Measurement of road user characteristics.
8. Use of automatic traffic recording equipment

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II – SEMESTER

TE-2.1-TRAFFIC FLOW ANALYSIS

Traffic Flow Description: Traffic Stream Characteristics and Description Using Distributions: Measurement, Microscopic and Macroscopic Study of Traffic Stream Characteristics - Flow, Speed and Concentration; Use of Counting, Interval and Translated Distributions for Describing Vehicle Arrivals, Headways, Speeds, Gaps and Lags; Fitting of Distributions, Goodness of Fit Tests.

Traffic Stream Models: Fundamental Equation of Traffic Flow, Speed-
Flow-Concentration Relationships, Normalised Relationship, Fluid Flow Analogy Approach, Shock Wave Theory - Flow-Density diagram use in Shockwave analysis; Use of Time-space diagram for shockwave description; Bottleneck situations and shockwaves; traffic signal and shockwave theory; numerical Examples for application of shockwave theory;, Platoon Diffusion and Boltzman Like Behavior of Traffic Flow, Car-Following Theory, Linear and Non-Linear Car-Following Models, Acceleration Noise, Fuel consumption models

Queuing Analysis: Fundamentals of Queuing Theory, Demand Service Characteristics, Deterministic Queuing Models, Stochastic Queuing Models, Multiple Service Channels, Analysis of M/M/1 system; Assumptions and Derivation of System State Equations; Application of M/M/1 analysis for parking Garages and Toll Plazas- numerical Examples; Analysis of D/D/1 system for delay characteristics; Traffic Signal analysis as D/D/1 system; Computation of delays and queue dissipation Time – Numerical Examples.

Pedestrian Delays And Gaps: Pedestrian Gap acceptance and delays; Concept of Blocks, Anti-blocks, Gaps and Non-Gaps; Underwood's analysis for Pedestrian Delays; Warrants for Pedestrian Crossing Facilities – Minimum Vehicular Volume Warrant, Minimum Pedestrian Volume Warrant, Maximum Pedestrian Volume Warrant.

Simulation Models: Philosophy of Simulation Modelling, Formulation of Simulation Model, Methodology of System Simulation, Simulation Languages, Generation of Random Numbers, Generation of Inputs – Vehicle Arrivals, Vehicle Characteristics, Road Geometrics, Design of Computer Simulation Experiments, Analysis of Simulation Data,
Formulation of Simulation Problems in Traffic Engineering and Validation.; Basic concepts of simulation modelling application for Signalised Intersections, Pedestrian Crossings and Transit scheduling.

References:
1.   Traffic Flow Theory: A Monograph , TRB Special Report 165
2.   Fundamentals of Transportation Engineering – C.S.Papacostas, Prentice

3.	Hall India Publication
4.	Principles of Highway Engineering and Traffic Analysis – F.L.Mannering
5.	& W.P.Kilareski, John Wiley Publishers.
6.	Traffic Flow Fundamentals – A.D.May, , Prentice Hall India Publication
7.	Fundamentals of Traffic Engineering – McShane & Rogers

TE-2.2-TRANSPORTATION ECONOMICS AND PROJECT APPRAISAL

Transport Economics And Analysis: Review of Engineering Economics and Microeconomics, Welfare Theory and Equilibrium Conditions, Goals and Objectives, Principles of Economic Analysis. Discounted Cash Flows: Analysis of User Costs and Benefits, RUCS Models for Costs and Benefits, Methods of Economic Analysis; Suitability, Analysis for Null Alternative

Investment Policies And Pricing: Average Cost, Marginal Cost, Allocation of Resources within Transport Sectors, Financing of Transport Sectors, Transport Investment Policies - Pricing Policies. Issues in transport policy: Budgeting, Non-user Impact Analysis, Analysis of Related Endeavour, Monitoring and Continuous Evaluation Strategies, Case Studies.

System Selection, Evaluation And Cost Analysis: Framework of Evaluation, Transport Planning Evaluation at Urban andRegional levels, Other Evaluation Procedures - Traditional Economic Analysis, Achievement Matrices, Factor Profiles, Plan Ranking, Introduction to Mathematical Programming, Case Studies.

Life cycle cost analysis: Factors consider for Life Cycle Cost Analysis; Data requirements for highway project feasibility analysis, establishment of Technical/ Economic/ Financial feasibility of a highway project, Social Benefits, Role of HDM in feasibility studies.

Project Appraisal - Private Sector Participation: BOT, BOOT, BOLT Projects - Case history - Project Planning - Project System Management - Project Implementation - Funds Planning – Budgetary and Control - Tendering and Contract - Value Analysis, Information System - Impact assessment, Project Report Preparation.

TQM in Highway Projects: Need for TQM, TQM Principles, Phases in TQM - Conceptual stage to Operations staqe, TQM in Traffic & Transportation projects, Case Studies.

References:
1. Highway investment in Developing countries - Thomas Telford Ltd.,Institute of Civil Engineers
2. Winfrey R, Economic Analysis for Highways - International Text Book Co., Pennsylvania
3. Road User Cost Study - Final Report - Central Road Research Institute, New Delhi
4. Dickey, J.W. - Road Project Appraisal for Developing countries, JohnWiley and Sons.
5. Lan Heggie, Transport Engineering Economics, McGraw Hill

TE 2.3- AIRPORT PLANNING AND DESIGN

Aircraft characteristics. Obstruction criteria., Air traffic control.
Runways: Orientation, length, geometric standards, capacity, configuration, Taxiway, geometric standards, fillets, high speed exit taxiway, Apron-gate area and circulation.
Terminal building – functional areas and facilities, The planning and site selection, Pavement design and evaluation.
Visual aids, Drainage, Heliports.

References:
1.   Airport Planning and Design by Khanna and Arora.

TE2.4 ANALYSIS OF TRANSPORTATION SYSTEMS

Traffic Regualtions**:** Purpose and Scope, One way streets; reversible lanes and road ways; Turn regulations, Transit and Carpool lanes, Bicycle lanes and Bikeways, Pedestrian only streets, Speed Regulations, Passing and No Passing Regulations; Stop and yield controls.

Traffic Management**:** Need for Traffic Management, Basic Traffic Management Activities, Traffic Management Strategies and their Coordination; Access Management, Congestion Management, Traffic Calming, Evaluation of Traffic Management Systems.

Transportation System Management: Objectives, Need for TSM Long – Range vs. TSM Planning; TSM Actions, Traffic Management Techniques for improving Vehicular Flows, Preferential Treatment for High Occupancy Modes; Promoting Non- Auto and High Occupancy Vehicles; Transit and Intermediate public Transport service improvements, Demand Management Techniques for Reduced Intermediate Public Transport service improvements, Demand Management Techniques for Reduced Traffic Demand, Staggered Working Hours, Vehicular Restrictions, Intersection management techniques- Signal Progression – Optimization.

Local Area Traffic Management: Pedestrian Facilities; Bicycle Facilities; Traffic Planning and Management at Local Level; Individual Sites, Residential Neighbourhoods and local interests, Traffic Effects of Land Use Developments.

Traffic Administration: Legislative Authority; Functional Responsibilities; Organization-UMTA-State Highway Department; Traffic Records; Research Bodies; Citizen Participation; Asset Management.

References:
1.   Institution of Transportation Engineers. Traffic Engineering Hand Book, 4 th ed., Prentice Hall
2.   Transportation System Management ,State of the Art,UMTA,USDOT
3.   Khisty CJ and BK Lall, Transportation Engineering: An Introduction Prentice Hall International,Inc
4.   Local Area Traffic Management, TRB Special Publications

TE 2.5(a) - PROBABILITY AND STATISTICS

Fundamental concepts and role of probability and statistics in civil engineering, collection and presentation of data – design of experiment.
Elementary probability theory: random variables, conditional probability, theorem of total probability and Baye's theorem.

Probability distributions: Gaussian and log normal, Binomial geometric, Poisson exponential, Gamma uniform, triangular, Hyper geometric, Beta, Student's 'T' , ψ square, Fischer's 'F'.

Extreme – value: Gamble distributions, Central limit theorem, Moments and Expectations, Covariance matrix and Covariance propagation, weights. Estimation of parameters: Method of least squares – observation equations, normal equations, linear and nonlinear models.

Confidence interval estimation and statistical testing: Tests of hypothesis and significance for mean, variance and ratio of variances, statistical inference, multi variety analysis, error analysis, error elapses derived probability distributions, goodness–of–fit tests.

Regression: Linear, Non-linear and Multiple–linear Correlation analysis, Applications in Civil engineering.

References:
1.   Ang, H.S. and Tang, W.H., Probability Concepts in Engineering Planning and Design, Wiley, New York, 1975.
2.   Benjamin, J.R. and Cornell, C.A., Probability Statistics and Decision for Civil Engineers, McGraw Hill, New York, 1975.
3.   Statistical Techniques for Transportation Engineering by Kumar Molugarm and Shanker Rao, BSP Books PVT Ltd

TE-2.5 (b) : PAVEMENT MATERIALS

Subgrade functions, Importance of subgrade soil properties on pavement performance. Identification and significance of soil characteristics, Soil classification, Effect of water on swelling and shrinkage, Cohesion and Plasticity.

Road making aggregates - Classification, Properties of aggregates, design of aggregate gradation, texture, polishing and skid resistance.

Bituminous road binders - Straight- run bitumen, emulsions, Cutback and modified binders. Rheology of bituminous binders, modified binders - adhesion and stripping, penetration index, viscosity, temperature susceptibility of viscosity. Additives and their suitability, Fillers.

Design of Bituminous mixes - Marshall method and super paves procedure.

Design of emulsified mixes, Visco-elastic and fatigue properties of bituminous mixtures, resilient modulus of pavement materials. Requirements of paving concrete, design of mixes - IRC, absolute volume, Road Note No.4, Vibrated Concrete mix design, design of DLC and SFRC mixes, Soil stabilization techniques.

Referances:

1.   Pavement Analysis and Design, second edition, by Yang H. Huang, Prentice Hall publishers. Shell Pavement Design Manual - asphalt pavements and overlays for road traffic, by Nilanjan Sarkar, Ooms Avenhorn Holding India Pvt.Ltd**;**
2.   Highway engineering by Khanna & Justo .

TE-2.5(c) FINITE ELEMENT METHOD OF ANALYSIS

Introduction: A brief history of F.E.M. Need of the method, Review of basic principles of solid mechanics, Equations of equilibrium, Boundary conditions, Compatibility, Strain displacement relations, Constitutive relationship.

Theory relating to the formulation of the finite element method, Coordinate system (local and global), Basic component – A single element. Derivation of stiffness matrix, Assembly of stiffness, Matrix boundary conditions – All with reference to trusses under axial forces.

Concept of element, Various element shapes, Triangular element. Discretisation of a structure, Mesh refinement Vs. Higher order element, Inter connections at nodes of displacement models on inter element compatibility.

Three dimensional analysis – Various elements used, Tetra-hedrons, Hex-hedrons. Requirements on representation of element behaviour functions, Polynomial series. Isoparametric representation and its formulation.

Books:

1.   "The Finite Element Method in Engineering Science" by Zienkiewicz, P., McGraw Hill, 1971.
2.   "Finite Element Analysis Fundamentals" by Richard H. Gallagher, Prentice Hall, 1975.
3.   "Introduction to Finite Element Method" by Desai, C.S. and Abela, J.F., Van Nostrand, 1972.
4.   "Finite Element Methods for Engineers" by Reger, T. Fenuer, The Macmillan Ltd., London, 1975.
5.   "Fundamentals of Finite Element Techniques for Structural Engineers" by Drabbia, C.A. and Conner, J.J., John Wiley and Sons, 1971.
6.   **"**Numerical Methods in Finite Element Analysis" by Klaus Jurgen and Edward, L., Wilson, Prentice Hall of India, New Delhi, 1978

TE 2.6 (a)- GROUND IMPROVEMENT TECHNIQUES

Ground Improvement:Principles of ground improvements, mechanical modification – principles of densification, properties of compacted soil, compaction control tests, specification for compaction.

Hydraulic modification – Dewatering and filtration, drainage and seepage control with geosynthetics, preloading and vertical drains, electro kinetic dewatering.Chemical modification, modification by admixtures, modification by inclusions and confinement, insitu ground reinforcement, ground anchorage, rock bolting, nailing.

Soil Reinforcement and Geosynthetics: History and development of earth reinforcement, geosynthetic materials, functions, properties, characterization. Testing methods for geotextiles and geomembranes, application areas. Principles of earth reinforcement. Mechanical and analytical considerations. Factors affecting the performance and behavior of reinforced soil, construction, durability.

Designing with geotextiles, geogrids, geomembranes, geocomposites for functions such as separation, reinforcement, filtration, drainage and moisture barrier.

References:
1.   Keorner, R.M. Designing with geosynthetics, Prentice Hall. Jones "Earth reinforcement and soil structure" Butter Worths 1996.
2.   Monfred R. Hausman, 1990, Mc.Graw Hill publishing Corporation. IS code 13094-1992, Selection of Ground Improvement Techniques for Foundation in Week Soils – Guidelines.

TE-2.6 (b) : GIS APPLICATION IN TRANSPORTATION ENGINEERING

Introduction to GIS: Introduction, GIS over view, use of GIS in decision making, Data processing, Components of GIS, The GIS and the organization. Data input - Key board entry, Manual digitizing, Scanning, Remotely and sensed data,existing digital data, census related data sets, Data output - Hard copy and soft, copy devices.

Data Quality: Components of data quality - Micro level, Macro level components, Sources of error, A note about data accuracy. Data Management .The data base approach, 3 classic data models, Nature of geographic data, Spatial data models, Databases for GIS.

GIS Analysis and Functions: Organizing geographic data for analysis, Maintenance and analysis of the spatial data and non-spatial attribute data and its integration output formatting. Implementing a GIS Awareness, Developing system requirements, Evaluation of alternative systems, System justification and Development of an implementation plan, System acquisition and start up, Operation of the system.

Application of GIS in Transportation Engineering - I : Intelligent information system for road accessibility study, GIS data base design for physical facility planning, Decision support systems for land use planning

Application of GIS in Transportation Engineering - II: GIS applications in environment impact assessment, GIS based Highway alignment, GIS based road network planning, GIS based traffic congestion analysis and accident investigation.

References:
1.   GIS A Management, Perspenfi Stan Aronoff, WDL Publisher.
2.   GIS by Lo Yeng, PHI Publications

TE-2.6 (c): ENVIRONMENTAL IMPACT ASSESSMENT

Introduction: Environment and its interaction with human activities – Environmental imbalances ¬Attributes, Impacts, 'Indicators and Measurements - Concept of Environmental Impact Assessment (EIA),Environmental Impact Statement, Objectives of EIA, Advantages and Limitations

Environmental Indicators - Indicators for climate - Indicators for terrestrial subsystems - Indicators for aquatic subsystems – Selection of indicators - Socia-economic indicators - Basic information – Indicators for economy - Social indicators - Indicators for health and nutrition - Cultural indicators - Selection of indicators.

Environmental issues in water resource development - Land use – Soil erosion C1nd their short and long term effects - Disturbance and long term impacts - Changes in quantity and quality of flow ¬Sedimentation–Environmental impact assessment of water resource development structures – Gase studies, Water Quality Impact Assessment -
Attributes, Water Quality, Impact Assessment of Water. Resources Projects, Data Requirements of Water Quality Impact Assessment for Dams, Impacts of Dams on Environment, Case Studies.

Environmental Issues in Industrial Development: On-site and Off-site impacts during various stages of industrial development, Long term climatic changes, Green house effect, Industrial effluents and their impact on natural cycle, Environmental impact of Highways, Mining'and Energy development

Methodologies for Carrying Environmental Impact Assessment: Overview of Methodologies .Ad hoc,Checklist, Matrix, Network, Overlays, Benefit Cost Analysis, Choosing A Methodology, Review Criteria.

References:
1.   Jain, R.K., Urban, L.V., Stracy, G.S., (1991), "Environmental Impact
Analysis", Van Nostrand Reinhold Co., New York
3.   Rau, J.G. and Wooten, D.C., (1996), "Environmental Impact Assessment",McGraw Hill Pub. Co.,New York
4.   UNESCO, (1987), "Methodological Guidelines for the Integrated Environmental

Evaluation of Water Resources Development",UNESCO/UNEP, Paris

5.   Canter, L.W., (1997), "Environmental Impact Assessment", McGraw Hill Pub. Co., New York.
6.   Environmental Impact Assessment Methodologies by Y Anjaneyulu, and Valli Manikkam, BSP Books PVT Ltd
7.   Environmental Impact Assessment by Anji Reddy, BSP Books PVT Ltd

TE 2.7 PAVEMENT MATERIALS AND EVALUATION LABORATORY

1.   Tests on aggregates,
2.   Tests on bitumen,
3.   Tests on subgrade soil,
4.   Mix design of bitumen and aggregates for different construction techniques.

TE- 2.8: DESIGN PROJECT AND SEMINAR

The student has to do a mini project in the area of Transportation and present the work in the form of a report and deliver a seminar under the direction of the teacher.